America's First Aeronautical Magazine

AVIATION

1946
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THIS ISSUE

CAL ENGINEERING TOR-WING CRAFT

Stanley inaugu- most important on helicopter de- nd construction, ting much hith- published basic ation.

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DIER BEWARE!

ely warning and appraisal for no plan to invest ime and money flying game.

★

QUIETER AIRPLANES

's K. R. Jackman pre- ew methods and tools oat the noise problem thus increase aircraft and utility.

★

RSONIC AIRPLANES ARE HERE

veals imminent assault nsonic barrier, also an- s series of jet bombers development.

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WHAT PRICE RECONVERSION?

Financial Editor checks us of the aircraft uring industry, ana- t's year's earnings po- s. . . First of a two-part e.

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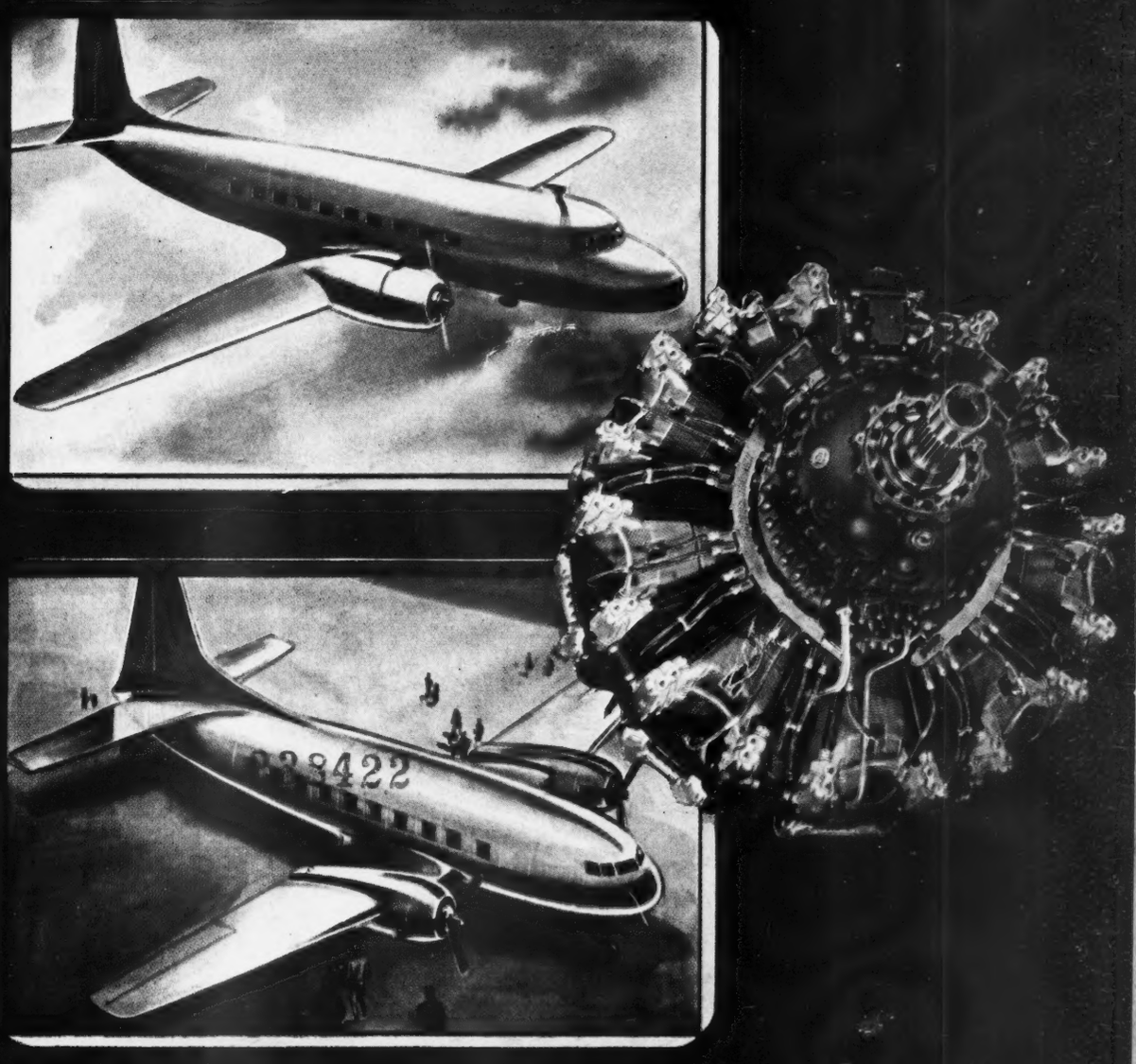

Dependable Power for Both

Again it's Pratt & Whitney power for postwar aircraft. Now it's the Consolidated-Vultee 240 and Martin 202 and 303. Each of these new aircraft, capable of carrying 30-40 passengers at 300 m.p.h., will be powered by two R-2800 dependable Double Wasp engines.

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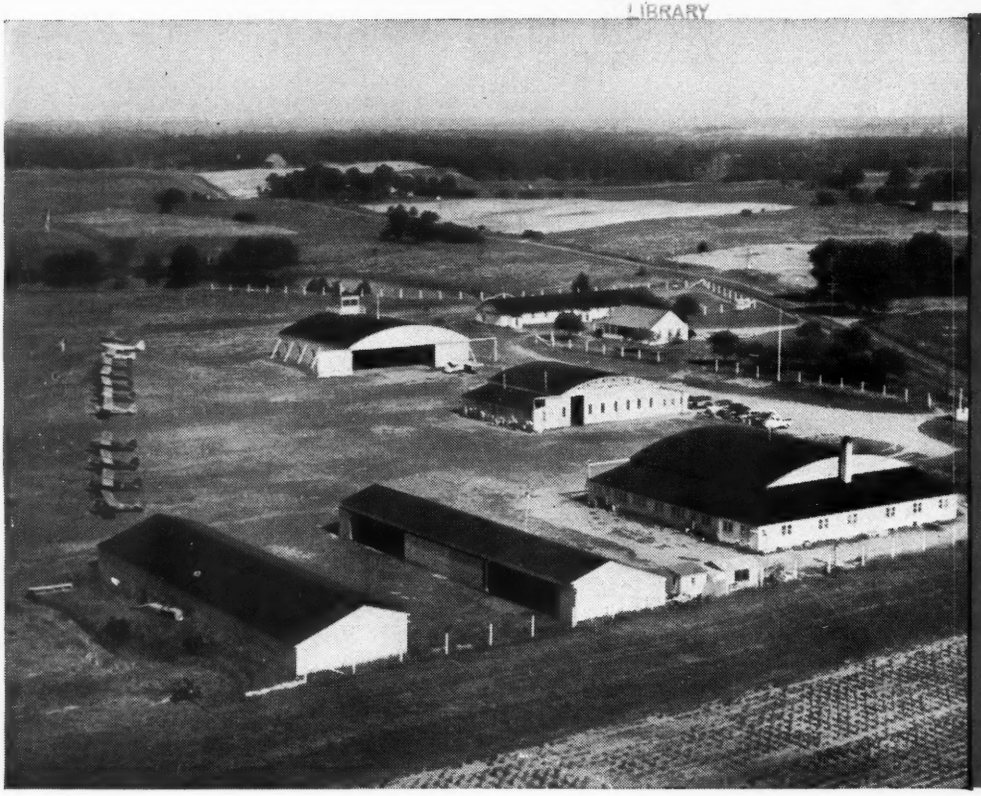

Thomas Hunt North, owner and president of North Aviation Co., personally manages Northport Airport—has been in aviation for years as fixed-base operator, flight instructor, and commercial pilot.

Aerial view of Northport's shops, hangars, control tower, restaurant and flight line—part of the complete set-up designed to give the private flier friendly, efficient service.

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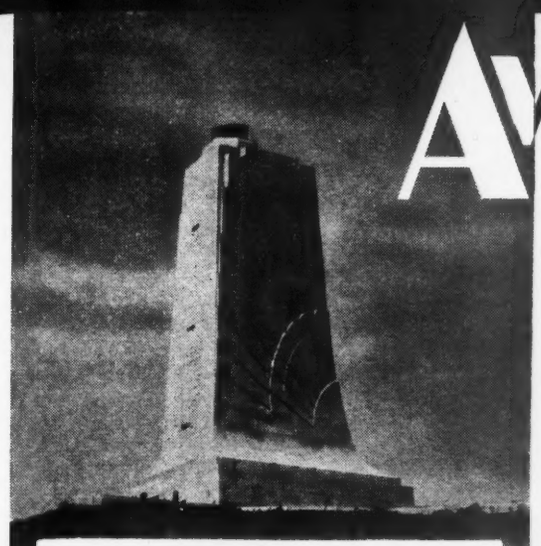

AVIATION

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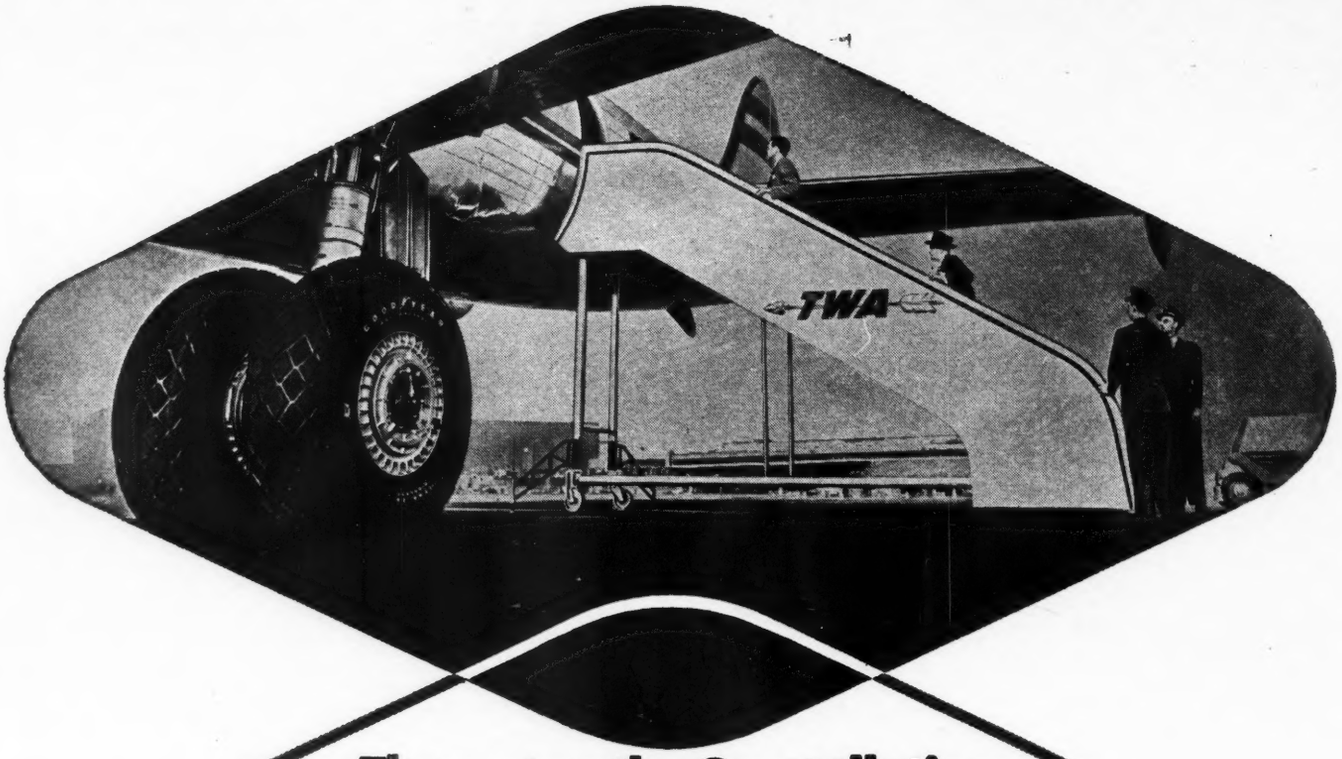

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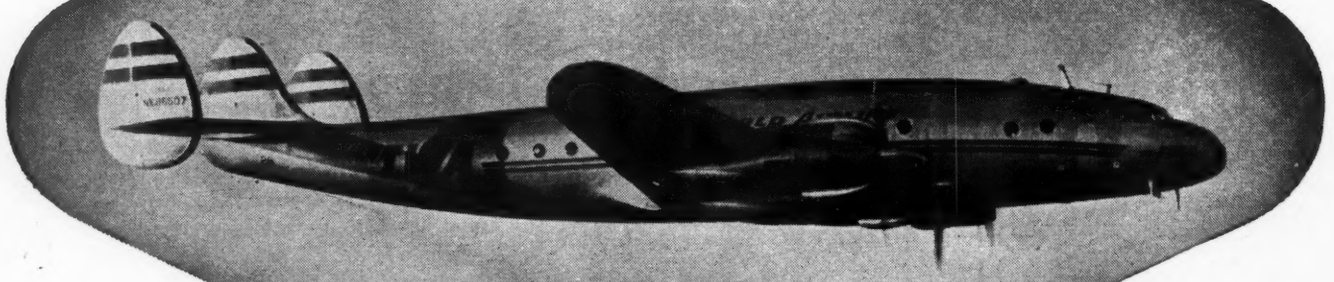

More aircraft land on Goodyear tires than on any other kind

"Keep 'em flying" is only part of the story today—for design and production engineers and operators must not only keep 'em in the air, they must also keep 'em quiet if complete comfort is to be an inherent quality of both transport and personal aircraft. In their efforts to cut down on the dinning decibels, Consolidated Vultee turned Chief Test Engineer Ken Jackman and his associates loose with only one requirement—reduce the noise. The result was a completely fresh approach—with new tools—to the whole field of aircraft acoustical problems. The methods and equipment they developed in their quest are ably presented in Jackman's own four-part series, beginning on page 75.

Ken MacDonald, manager of the San Francisco Chamber of Commerce Aviation Department has, we think, done both the industry and countless ex-servicemen a signal service by preparing the feature article which we present on pages 39–41. For in it he gives some very sage advice to all those young men and women back from the war who plan on "going into aviation." He doesn't deny the many opportunities the industry offers, but he does point out the many expensive pitfalls—points them out so clearly that the article is just as valuable for those already in the business.

PAUL STANLEY, CHIEF ENGINEER of the Autogiro Co. of America, runs a final calculation-check on what we believe to be the most important overall rotary wing work yet written. In every sense of the word it lives up to its title, "Practical Engineering of Rotary Wing Aircraft," and we are—to put it mildly—more than a little proud to present much of this work of Paul and his associates in series form, starting this month on page 55. For those who came into the rotary wing field late, here's a brief on Paul's background: He was aeronautical engineer, Flying Branch, McCook and Wright Fields from 1925 to 1929, when he became associated with Harold Pitcairn, with whom he has worked ever since. He also worked directly with the late Dr. Juan de la Cierva when this Spanish genius was putting his engineering theory together; has a dozen or so inventions in the rotary wing field; and has personally designed more than 40 different rotary wing blades.

Opportunities to use many of the war-created flight training facilities are outlined in the story of one successful reconversion, that done by Bevo Howard in South Carolina, where he took his war-baby Hawthorne flight training facilities and set up a complete maintenance and service network that already is doing an outstanding civilian business. The how's and why's are given in the article beginning on page 46.

This year 1946 is a crucial one financially for America's sorely needed aircraft manufacturing industry. It's crucial because of reconversion costs—those terrific items which are largely beyond control of the industry itself. To see just where the companies are likely to end up, Financial Editor Ray Hoadley has prepared a searching survey of their status as of the mid-year, with an analysis of what the whole year's operations may show on the profit and loss statements. It starts on page 84.

MEET YOUR Atom Bomb Test reporters—two specialists who'll bring first-hand reports to Aviation readers on one of the most important—if not actually THE Number One—experiments ever conducted by man. Scholer Bangs (left) Aviation's dynamic Pacific Coast Editor, has been flown to the AAF base at Kwajalein, from where he will dispatch a specialized story on the many ramifications of the airplane's huge part in the test. Phil Swain (right) editor of McGraw-Hill's "Power" and "Atomic Energy," went out aboard the Navy's press ship, and he will forward an overall story on the A-bomb experiment from that point. And, to continue giving Aviation readers complete coverage on the Atomic Age, all the McGraw-Hill resources have been employed to prepare a coming special 8-page section covering the first year's development.

Down the Years in AVIATION'S Log

25 Yr. Ago (1921) — "Aeronautical Journal" advocates large bombers with no exterior wing bracing. . . . Navy conducts bombing tests on obsolete battleships. . . . Deutsch prizes offered for international speed competition. . . . Airliner Engineering Corp. builds twin-engine 8,600-lb. biplane transport, seating 30 passengers. . . . Marine Corps uses DH-4 for delivering subchaser repair parts at sea. . . . There are now 12 active aviation clubs in U. S. . . . Packard builds V-12 engine delivering full power at 6,000 ft. . . . Sadi Lecointe breaks record at 220 mph. with Hisso-engined Nieuport. . . . Lts. Macready and Langham break two-man altitude record at 34,150 ft. in Lepere biplane with Moss-supercharged engine.

15 Yr. Ago (1931) —Packard-Diesel-powered Bellanca, flown by W. Lees and F. A. Brossy, breaks non-refueling record, flying 84 hr., 33 min. . . . French Lts. Paris and Gonard break seaplane record with 36 hr., 48 min., 3,230-mi. flight. . . . Taking off from Paris, Frank Hawks flies to London for breakfast, then to Berlin for lunch, and back to Paris for dinner, elapsed time being 7 hr. 31 min. . . . C. W. A. Scott flies from England to Australia and return in 20 days 3 hr. . . . Dornier DoX flies across Atlantic at 100 mph. . . . Air Corps flies 607 planes over 35,000 total hours in maneuvers without accident to personnel. . . . NACA opens new 60 x 30 ft. wind tunnel. . . . Kellett, Pitcairn, and Buhl produce autogiros. . . . Aero Chamber opens air safety conference.

10 Yr. Ago (1936)—North American's Pacific Coast factory starts production. . . . Emerson Mehlhose, of Wyandotte, Mich., makes new soaring altitude record of 6,516 ft. . . . UAL, now flying 1,500,000 mi. per mo., passes 100,000,000-mi. mark. . . . D. of C. tests blind landing equipment for transports. . . . Navy orders 191 new planes and Army orders 77. . . . In one month, Congress passes 19 bills dealing with aviation. . . . ATA holds eight regional conferences in place of single central meeting.

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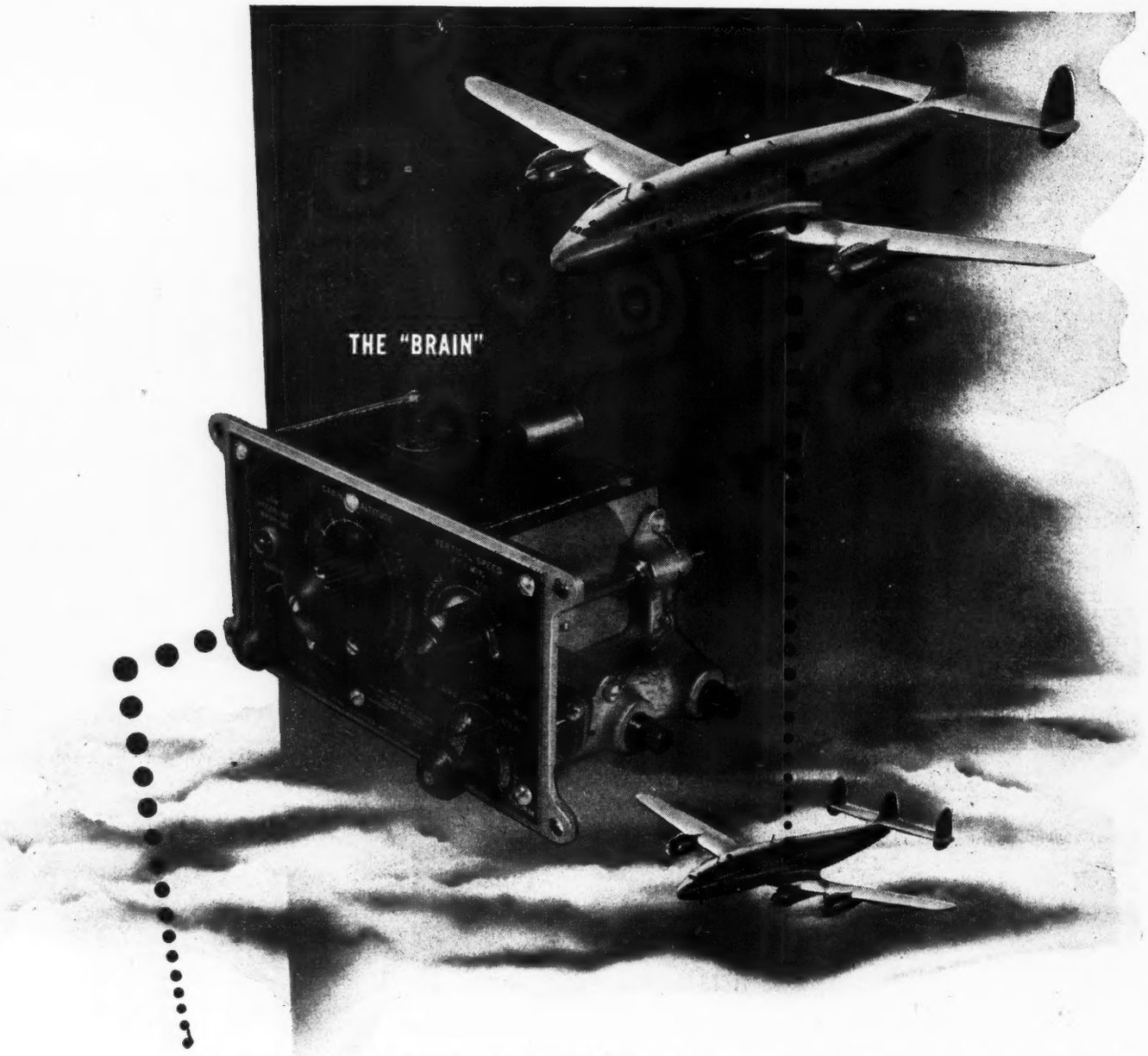

CABIN PRESSURIZATION CONTROL for high altitude aircraft calls upon a field of experience in which Kollsman has excelled for many years — the measurement and control of minute pressure differentials. Currently, it has developed and is manufacturing to Lockheed specifications the unique control unit used to regulate pressure in the Constellation's "Normalair" cabin. Aptly called the "brain", this unit consists of a highly sensitive interacting assembly of pressure detecting units and actuating mechanisms. It not only maintains cabin pressure at a pre-set figure, but arrives at it in accordance with a pre-determined rate of change. Further, it guards against too great a pressure differential between cabin interior and the atmosphere. Kollsman is also devoting its experience in pressure control and its background in the manufacture of practical precision devices to the development of similar units for other transport manufacturers.

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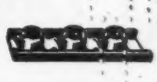
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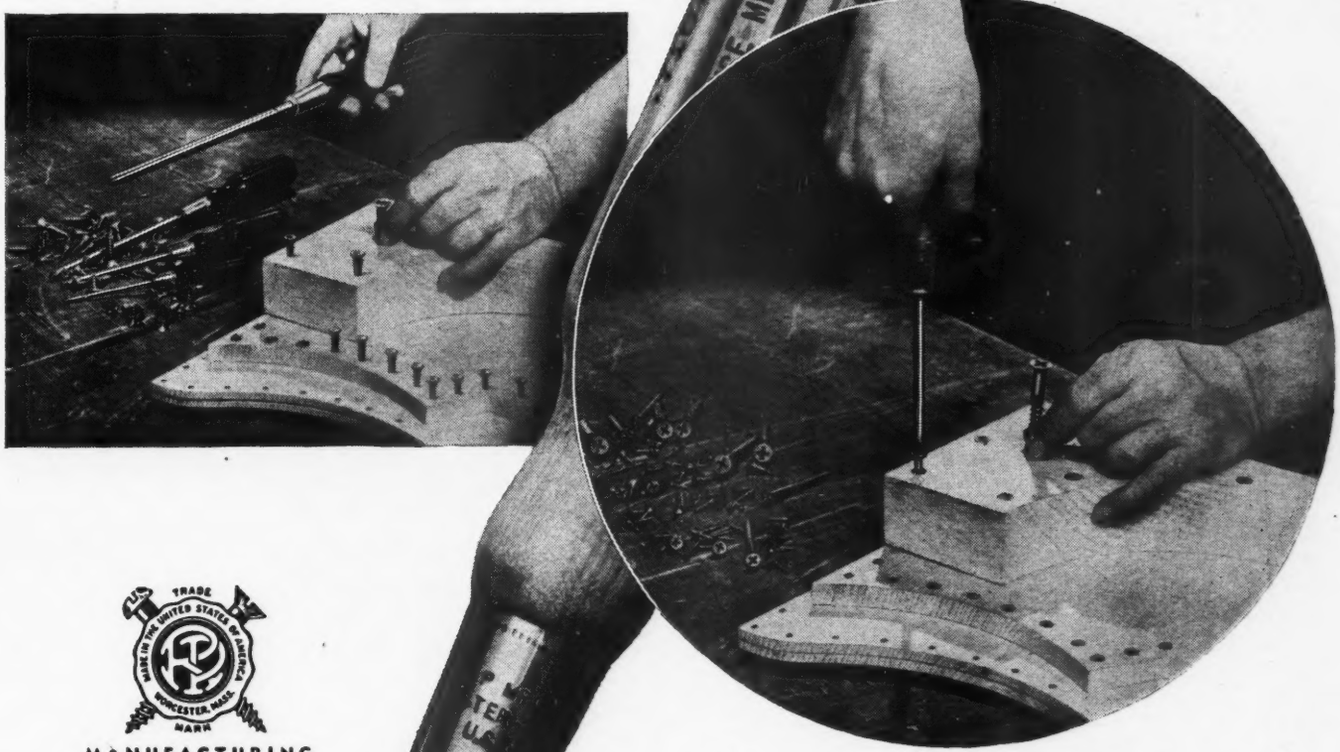

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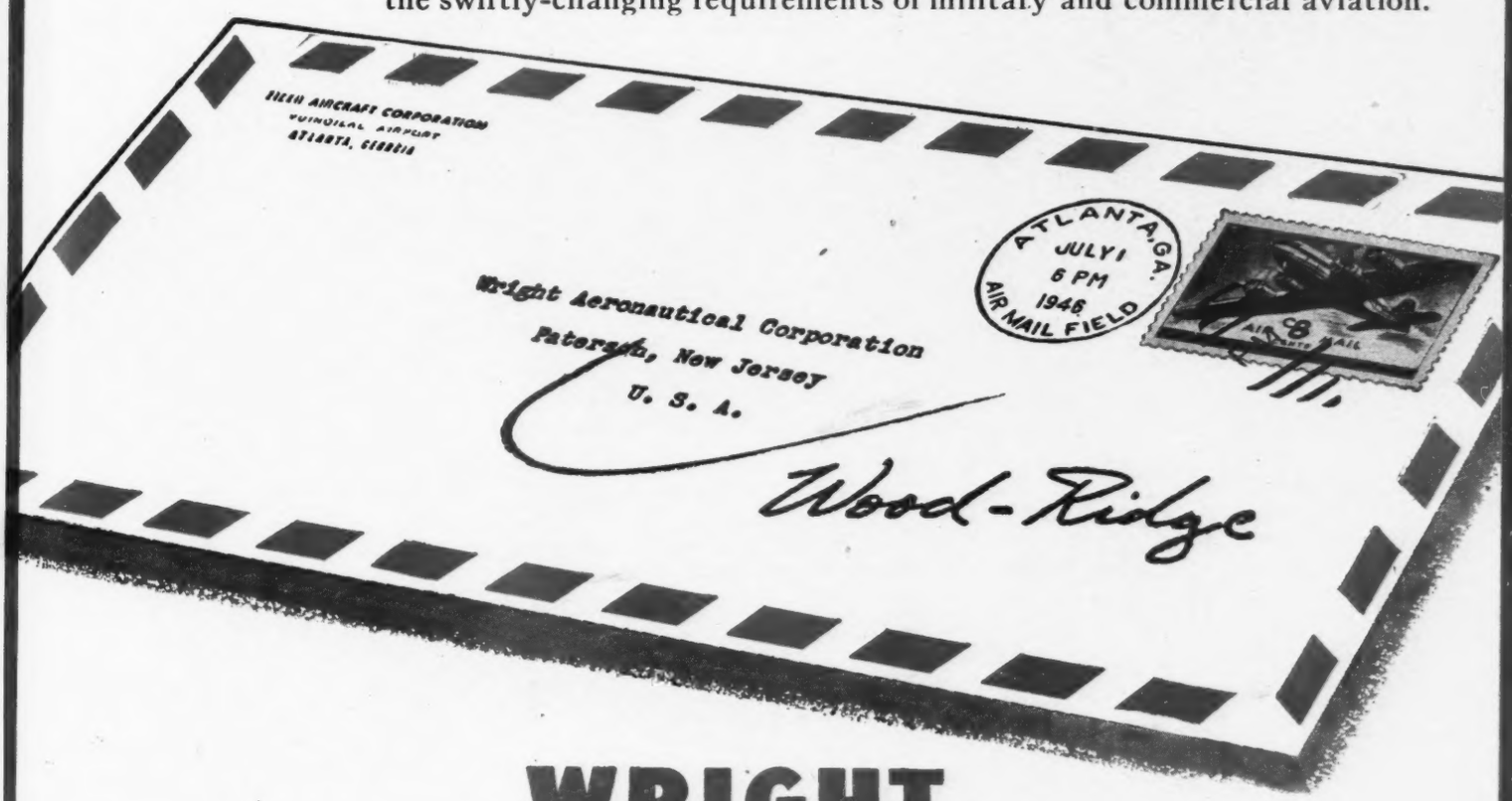

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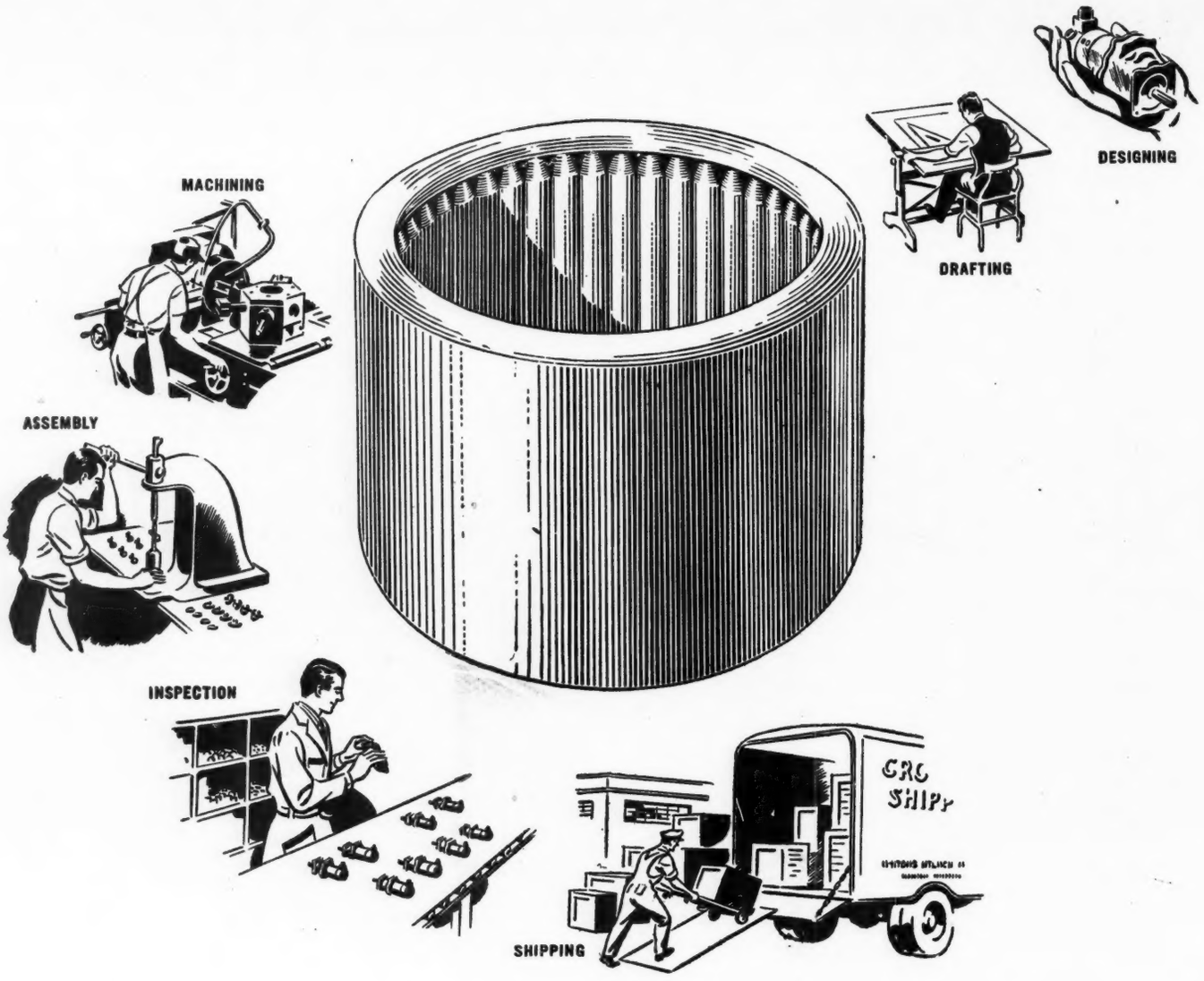

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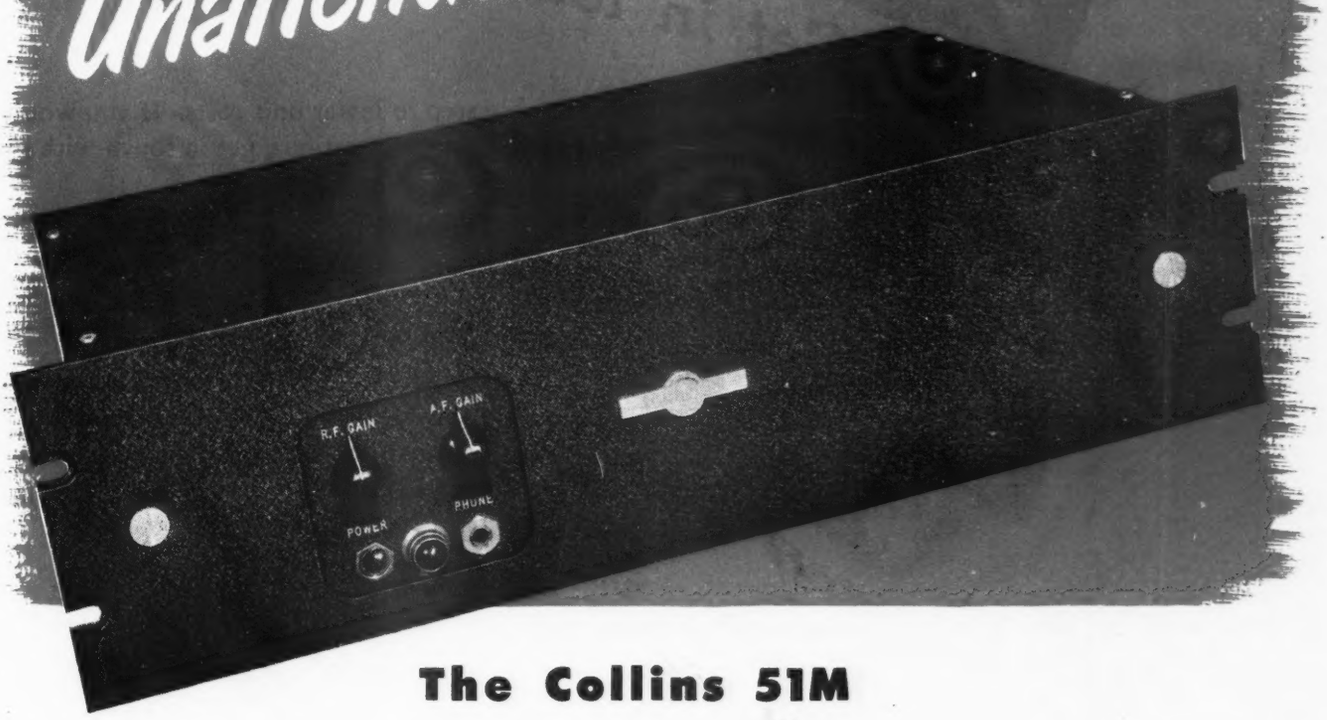

The Collins 51M

The 51M is the answer to your need for VHF reception or monitoring. It is engineered for continuous operation on a fixed, crystal controlled frequency between 118-132 mc, and can be located at a remote, unattended position. This new VHF receiver provides reliable reception under extreme variations of operating conditions—it incorporates improved protection against humidity and temperature changes, fungus growth, and very strong signals.

The output transformer has a balanced split secondary which can be used for simplex control circuits. Background noises can be effectively suppressed during the absence of a signal, by means of an adjustable carrier operated audio muting circuit.

The 51M has excellent sensitivity at a high signal to noise ratio. The band-width for reception is no less than 55 kc at 6 db attenuation and no more than 160 kc at 60 db attenuation. AVC provides essentially constant audio output. Write today for complete details.

Collins Radio Company, Cedar Rapids, Iowa
11 West 42nd Street, New York 18, N. Y.
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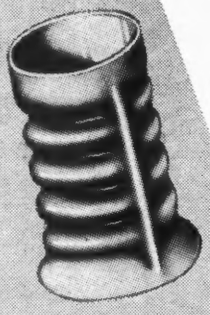
COLLINS

For Easier Fabrication of STAINLESS TUBING . . .

Get in touch with Carpenter

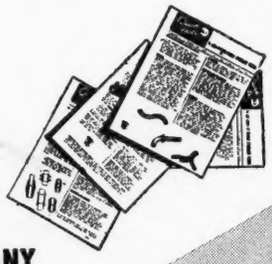
Easier fabrication of Stainless Tubing is a big step to lower unit costs. If you would like to speed bending, flanging, flaring and other operations, get in touch with us. We'll be glad to put our experience to work on your problems.

One of the best ways to cut fabricating costs is to specify *Carpenter Stainless Tubing* at the start of each job. Its uniform gauges save your time on each operation, and reduce rejects on final inspection. Each length is 100% hydrostatically tested.

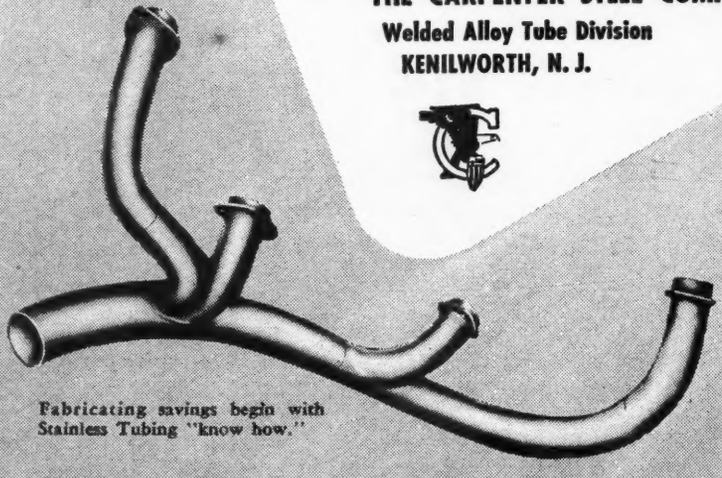


Intricate parts are produced faster from this tubing.

Quick Facts about Stainless Tubing . . . These bulletins contain useful data and many drawings that show the design and fabricating possibilities with Stainless Tubing. For your complete set of QUICK FACTS Bulletins, just drop us a note on your company letterhead.



THE CARPENTER STEEL COMPANY
Welded Alloy Tube Division
KENILWORTH, N. J.



Fabricating savings begin with Stainless Tubing "know how."

Uniform wall thickness throughout each length.

Carpenter
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STAINLESS TUBING

partners in creating

Many brilliant projects have been started with a K & E Slide Rule and the back of an old envelope. But between a new conception and its practical execution of the vital links are always the engineer and the draftsman. For through their techniques they construct the project on paper with unmistakable clarity and precision. In this their drafting instruments and equipment become part of their own hand and brain, and their partners in creating.

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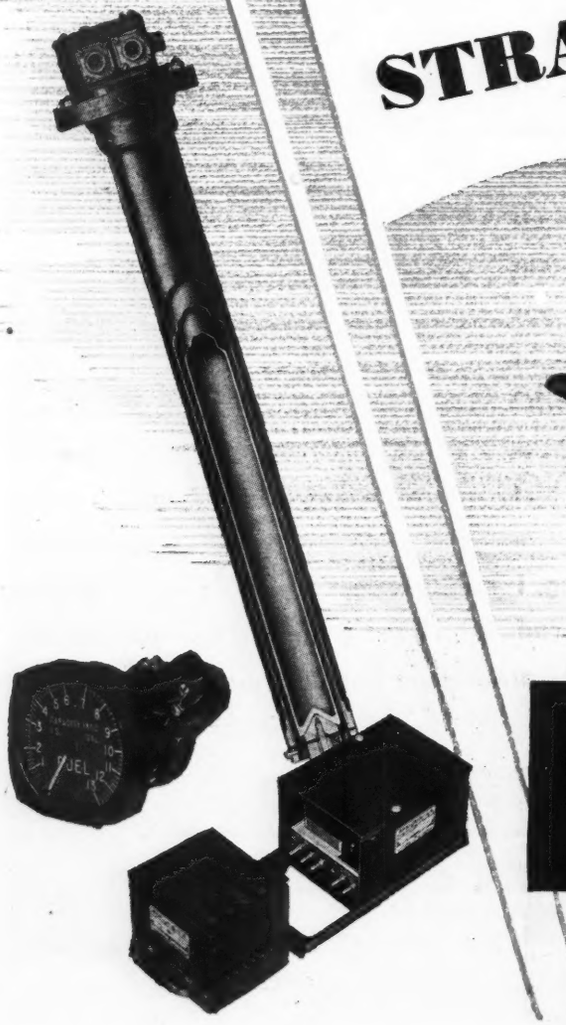
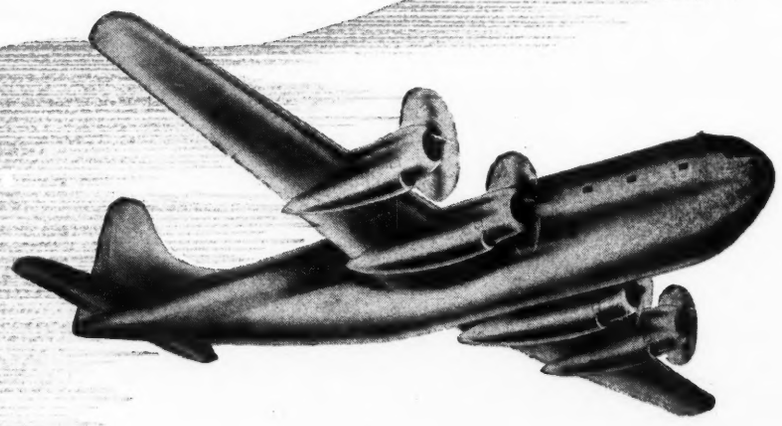
selects Honeywell
Electronic Fuel Gages
and Turbosupercharger Controls

for the NEW 377
STRATOCRUISER

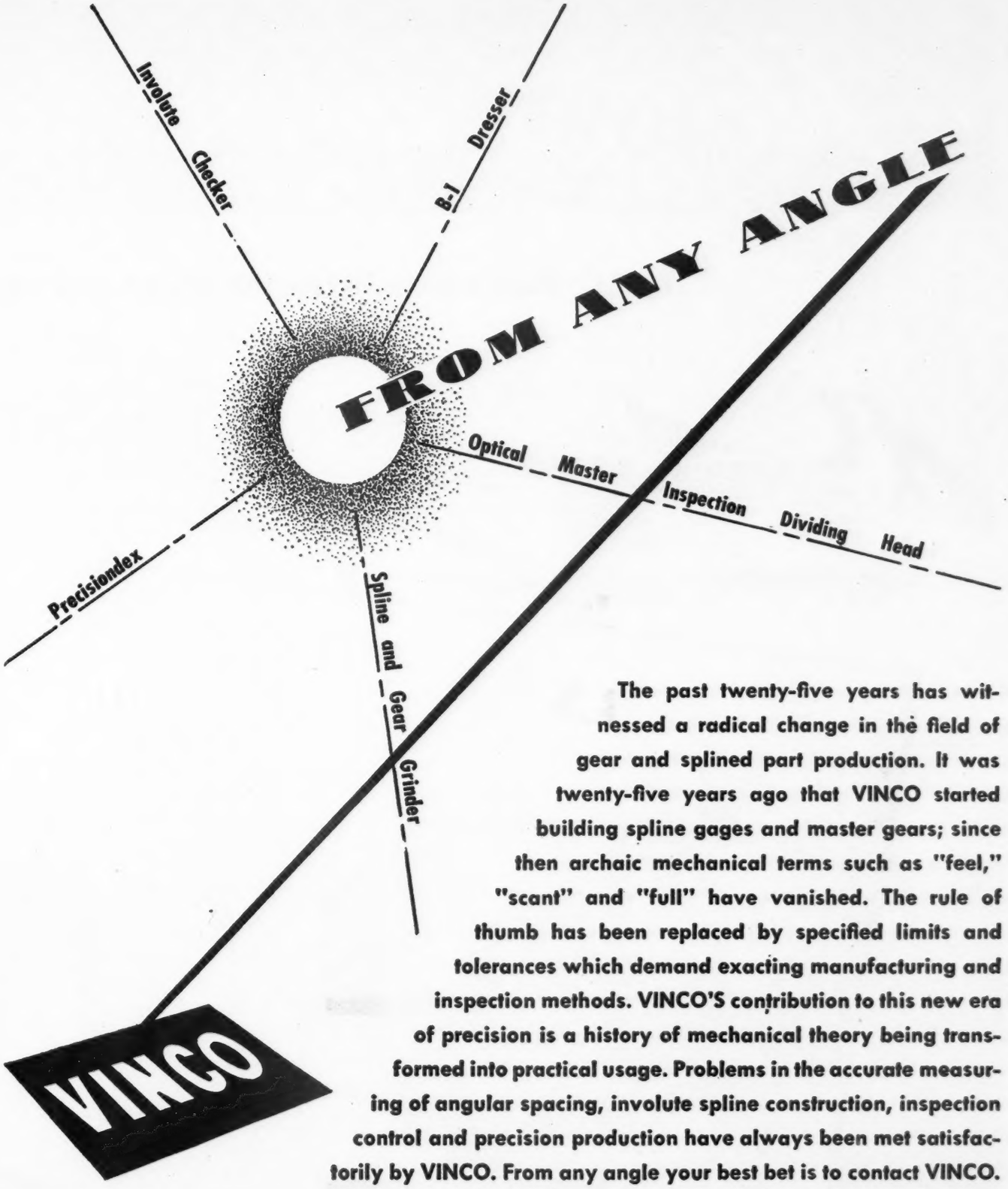




MINNEAPOLIS
Honeywell
CONTROL SYSTEMS

CREATIVE ENGINEERING

MAKERS OF THE FAMOUS M-H ELECTRONIC AUTOPILOT, USED ON AAF 4-ENGINED BOMBERS



The past twenty-five years has witnessed a radical change in the field of gear and splined part production. It was twenty-five years ago that VINCO started building spline gages and master gears; since then archaic mechanical terms such as "feel," "scant" and "full" have vanished. The rule of thumb has been replaced by specified limits and tolerances which demand exacting manufacturing and inspection methods. VINCO'S contribution to this new era of precision is a history of mechanical theory being transformed into practical usage. Problems in the accurate measuring of angular spacing, involute spline construction, inspection control and precision production have always been met satisfactorily by VINCO. From any angle your best bet is to contact VINCO.

MILLIONTHS OF AN INCH FOR SALE BY VINCO

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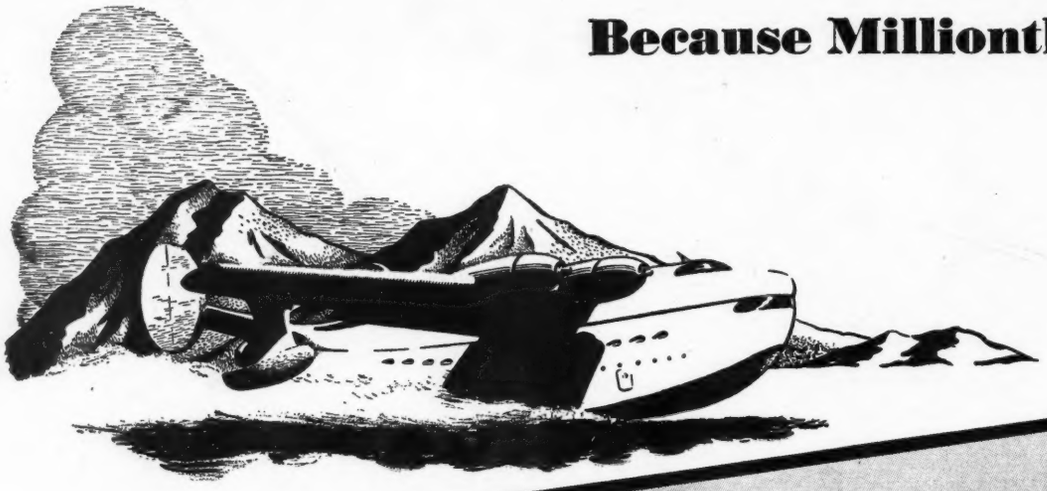
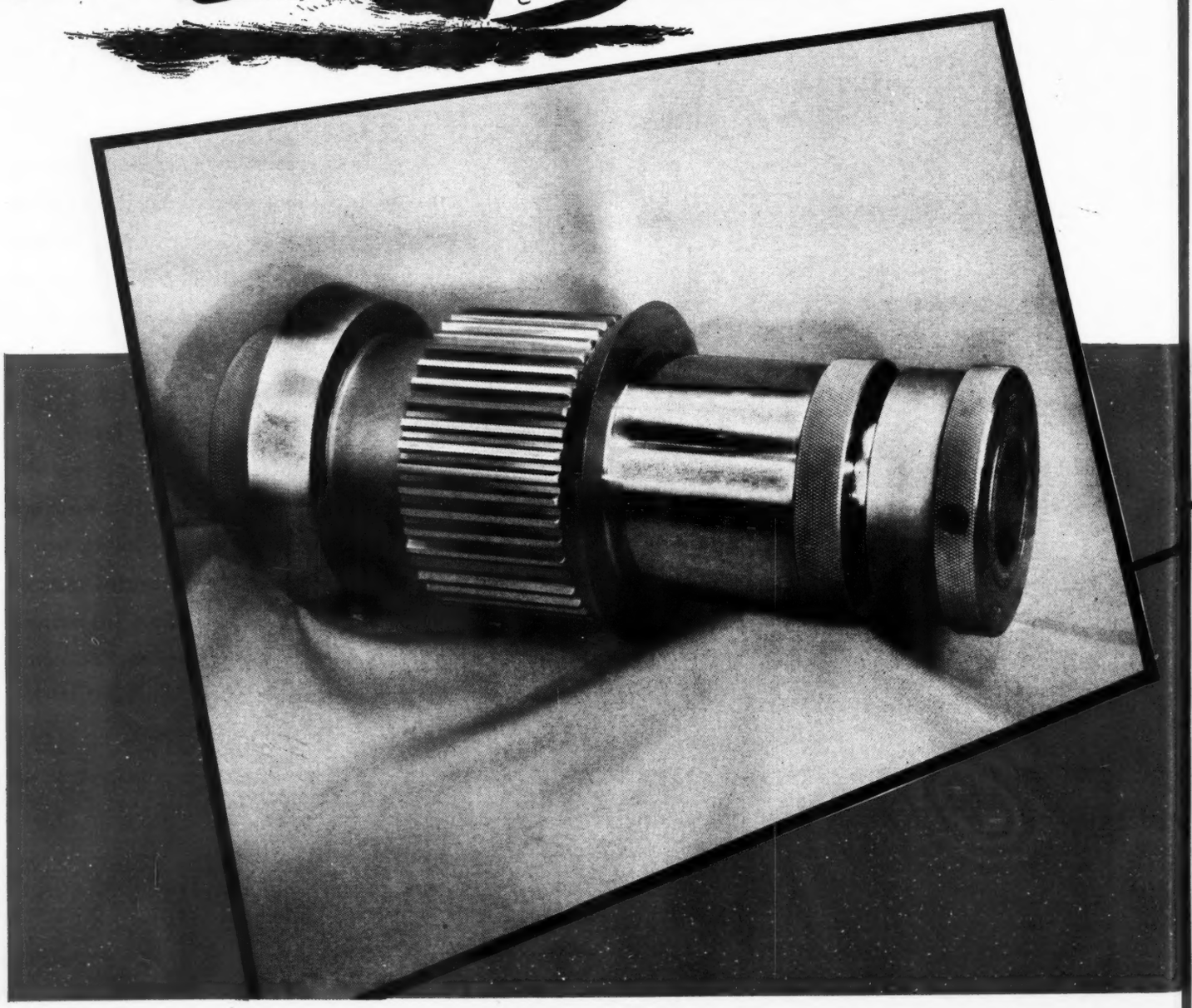
They Came to

Because Millionths of an Inch





VINCO

was a key to continued progress . . .

progress personified by the sleek, luxurious airliners about to make their debut to the world. The huge propellers and hub assemblies, which will loft and speed these airliners around the world, must be balanced so perfectly that the weight of a three cent stamp will start them revolving. Gages, like the one shown at the left will accept or reject these propeller assemblies.

This No. 80 hub spline gage, 17" long and having a 9½" O.D., is one of the largest built. Specified tolerances on all gaging elements were .0002" or less, and when this gage received inspection's final OK, all dimensions were "On the Nose."

Let "Millionths of an Inch" exactness smooth out your spline and precision production problems and cut down final assembly scrappage. Call VINCO.

VINCO CORPORATION, DETROIT 27, MICHIGAN

A department devoted to pilot line and experimental manufacture has been added to VINCO SERVICES. This is an outgrowth of an increasing customer demand for VINCO accuracy and finish on work of this nature. For more detailed information contact us directly, or call your VINCO representative.

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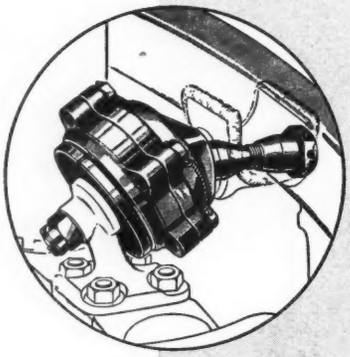
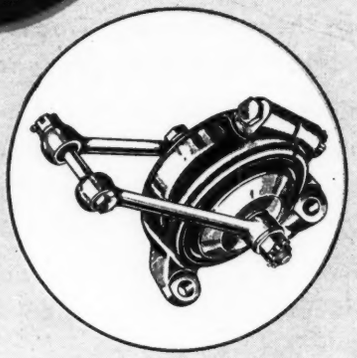
Install GENUINE **LORD** SHEAR TYPE *Dynafocal Engine* **MOUNTINGS** *Throughout*



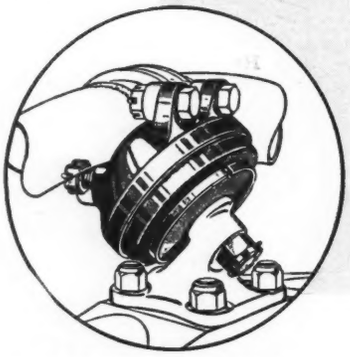
MR-26 ASSEMBLY
[Consists of eight MR-26-SA sub-assemblies]

For DOUGLAS DC-4 (C-54)
Using Pratt & Whitney R-2000 Series Engines



RL-35 ASSEMBLY
[Consists of nine RL-35-SA sub-assemblies]

For LOCKHEED "CONSTELLATION"
Using Wright R-3350 A & B Series Engines



MR-36 and MR-36F ASSEMBLIES
[Consists of six MR-36-SA or MR-36F-SA sub-assemblies]

For CURTISS CW-20 (C-46)
FAIRCHILD "PACKET" (C-82)
MARTIN 202
DOUGLAS DC-6 (C-112)
Using Pratt & Whitney R-2800 A & B Series Engines, use MR-36
Pratt & Whitney R-2800 C Series Engines, use MR-36F

LORD ENGINE MOUNTINGS FOR DC-3 (C-47)

J-1202-1 Bonded Rubber Tube Form Mounting (8 per plane)
J-1789-1 Bonded Rubber Insert (16 per plane)
SK-1292-1 Bonded Rubber Sandwich (32 per plane)
Using Pratt & Whitney R-1830 Series Engines

Individual Component parts for each of the above Dynafocal Assemblies are available for your maintenance and overhaul work.

WRITE FOR PARTS LIST

Every genuine Lord Mounting carries the name "LORD" embossed in the rubber or in raised letters on the forgings.

IT TAKES **BONDED RUBBER** *In Shear* TO ABSORB VIBRATION

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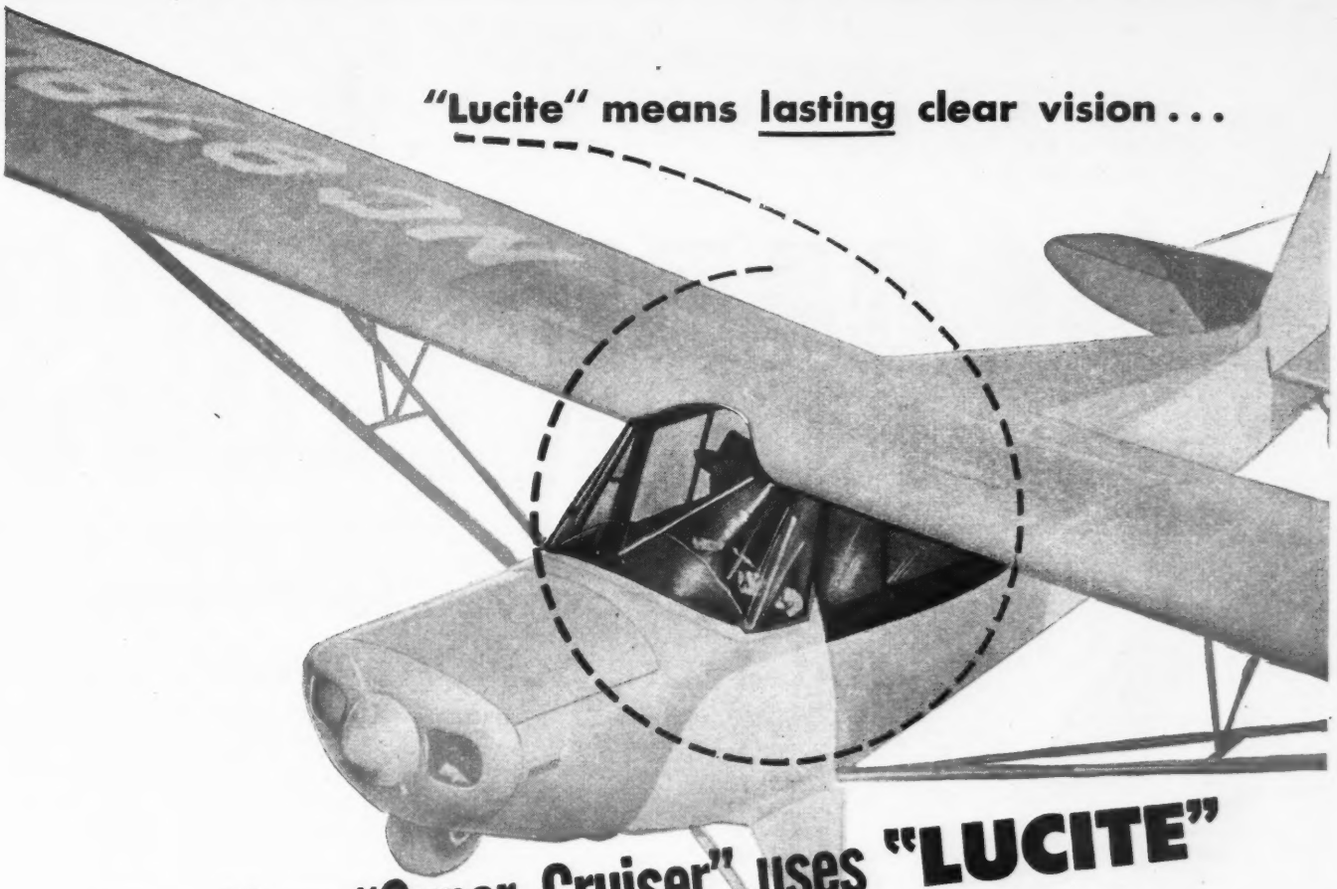
Originators of Shear Type Bonded Rubber Mountings



The Piper "Super Cruiser" uses "LUCITE" for windows, door, windshield

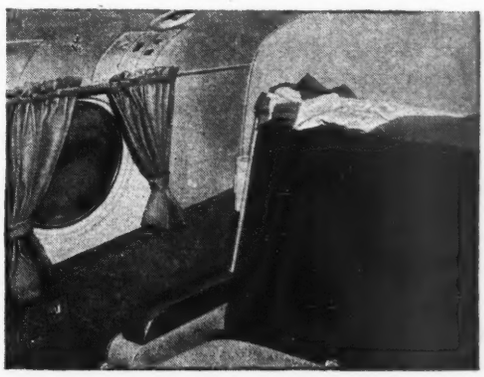
America's new peacetime planes are rapidly putting to use the many outstanding advantages of "Lucite" acrylic resin. Prominent among these advantages:

- **"LUCITE"** has crystal clarity—excellent optical qualities—transmits over 90% of the light rays.
- **"LUCITE"** stands "weathering"... is stable under extremes of sunlight, humidity, temperature.
- **"LUCITE"** has high tensile and flexural strength.
- **"LUCITE"** is light in weight.
- **"LUCITE"** is easily formed.
- In normal use, "Lucite" lasts the life of your plane.
- The cost is moderate—it was lowered five times during the war.

Write for free manual on "Lucite" for aircraft designers and engineers, maintenance men and owners. E. I. du Pont de Nemours & Co. (Inc.), Plastics Dept., Room 227, Arlington, N. J.

The Piper "Super Cruiser" is built by Piper Aircraft Corp., Lock Haven, Pa. Its 100-h. p. Lycoming motor carries 3 passengers at a cruising speed of 103 m. p. h. Other "quick facts" about the Piper Cruiser: Fuel capacity, 38 gal. Flying range, 600 miles. Useful load, 750 lbs. Electric starter. Generator. Navigation lights. Cabin heaters. Among the features claimed for this personal plane is the stability given by its high wing. Clear vision is assured by the enclosures of Du Pont "Lucite."

During the war every major type of combat aircraft employed "Lucite" in one or more applications.



What's New

On the larger planes, too, "Lucite" is chosen in many applications for its combination of properties which make for beauty and long service. Illustration shows a window of Du Pont "Lucite" on the Douglas DC-4.

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Plastics
BETTER THINGS FOR BETTER LIVING
. . . THROUGH CHEMISTRY

Announcing...A new SPARK PLUGS

C.A.A. Approved for Private and Transport Aircraft . . .

Auto-Lite Aircraft Spark Plugs are approved for use on Continental, Aircooled Motors and Lycoming engines.

AUTO-LITE MEANS PRECISION MANUFACTURING

18mm SHIELDED (SH-2K)

Outstanding features—Direct contact non-inductive resistor — Deep drawn copper cooled center electrode — Three prong ground electrode — Corundum insulator —Resilient type center seal eliminates leakage.

18mm UNSHIELDED (18 A-1)

Three prong ground electrode — Corundum insulator — One piece shell design — Resilient type center seal eliminates leakage.

AUTO-LITE AVIATION PRODUCTS INCLUDE: INSTRUMENTS AND GAUGES, BATTERIES, HIGH

AUTO-LITE

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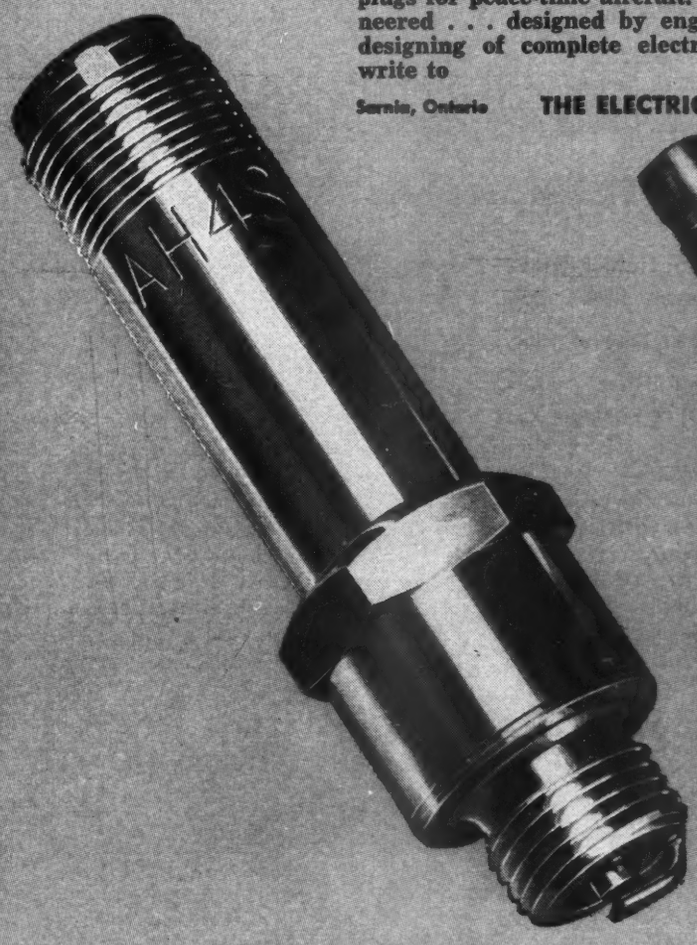
The developing and perfecting of new, improved spark plugs during the war years provides Auto-Lite with new skills for the building of spark plugs for peace-time aircraft. These new spark plugs are ignition engineered . . . designed by engineers with 35 years' experience in the designing of complete electrical systems. For complete information write to

Sarnia, Ontario **THE ELECTRIC AUTO-LITE COMPANY** Toledo 1, Ohio

TUNE IN THE AUTO-LITE RADIO SHOW STARRING DICK HAYMES—THURSDAYS 9:00 P.M. — E.T. ON CBS



14mm SHIELDED (AH4S)

Automotive gap geometry—Corundum insulator—One piece shell design—Resilient type center seal eliminates leakage.

14mm UNSHIELDED (AH4)

Automotive gap geometry—Corundum insulator—One-piece shell design—Resilient type center seal eliminates leakage.

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Aircraft SPARK PLUGS

Proved in war..now ready to serve peacetime Aviation

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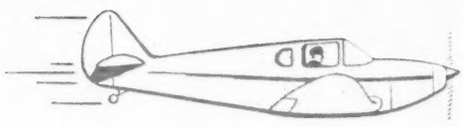

NON-SKID Walkway Coating

6 BIG ADVANTAGES FOR MANUFACTURERS AND OPERATORS

SPECIFICATIONS

Weight per sq. ft. of dried film: .88 ounces

Optimum film thickness: 10 mils

Coverage per gallon: 140 sq. feet

Applied full-body

Colors: Terra Cotta Red and Black available in quart, gallon and five gallon cans.

1. A LONGER-WEARING, LIGHTER-WEIGHT coating for walkways, floors, steps.
2. A FIRM FOOTING in spite of water, mud and oil.
3. SPEEDS PRODUCTION — single coat sufficient.
4. HIGHLY RESISTANT to 100 octane gasoline, engine oil and hydraulic fluid.
5. EXCELLENT ADHESION to aluminum, wood and fabric-covered surfaces.
6. LOW COST—offers material and labor savings.

TIME-TESTED PAINTS · VARNISHES · LACQUERS · ENAMELS

An achievement of Glidden research which filled many wartime uses with outstanding success, Glidair Non-Skid Walkway Coating is a corrosion-inhibiting, quick drying, paint type grit coating. It is quickly and easily brushed or trowelled on wing walkways, floors or steps in a tough, thin film. Glidair Distributors have supplies for dealers and operators. Manufacturers served by Glidden Aviation Sales Headquarters.

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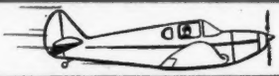
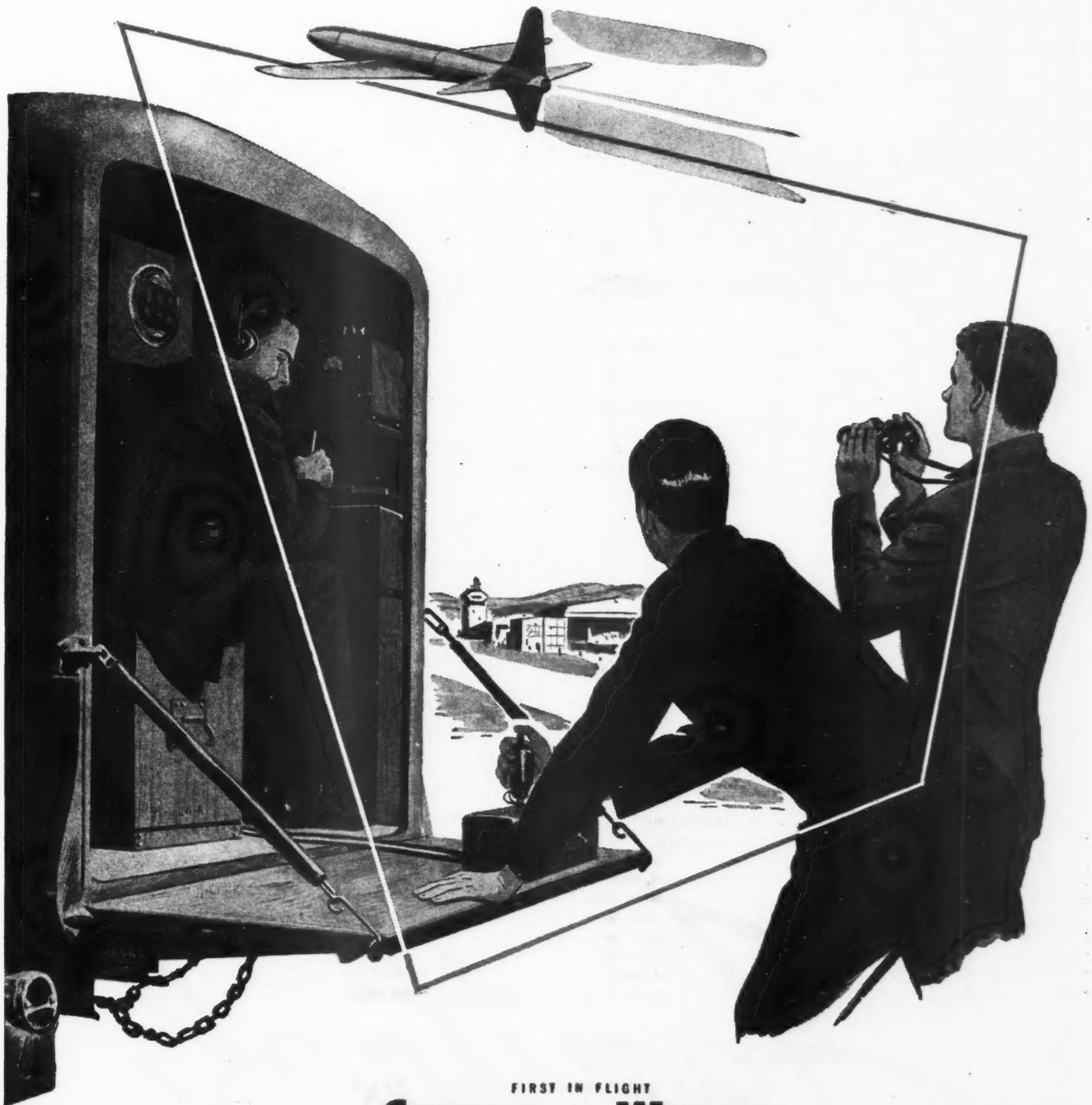


Made by **Glidden** · *Pacemaker in Paints*

test pilots on the ground

Telemetering — the instantaneous transmission of flight information to instruments on the ground — has opened new fields for obtaining scientific data on objects in flight. Whether piloted or pilotless, their exact behavior can be accurately determined during the entire flight, providing the engineer with information for further research and development. Combined with newly developed electronic control devices, this achievement of Curtiss-Wright research represents another advance in the era of supersonic flight.



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CURTISS WRIGHT

Airplane Division

COLUMBUS, OHIO

Developing Flight to Meet the Future.

DOUGLAS DC-6 IS *First* WITH
COMPLETE YEAR'ROUND
AIR CONDITIONING and
THERMAL ICE PREVENTION
SYSTEMS

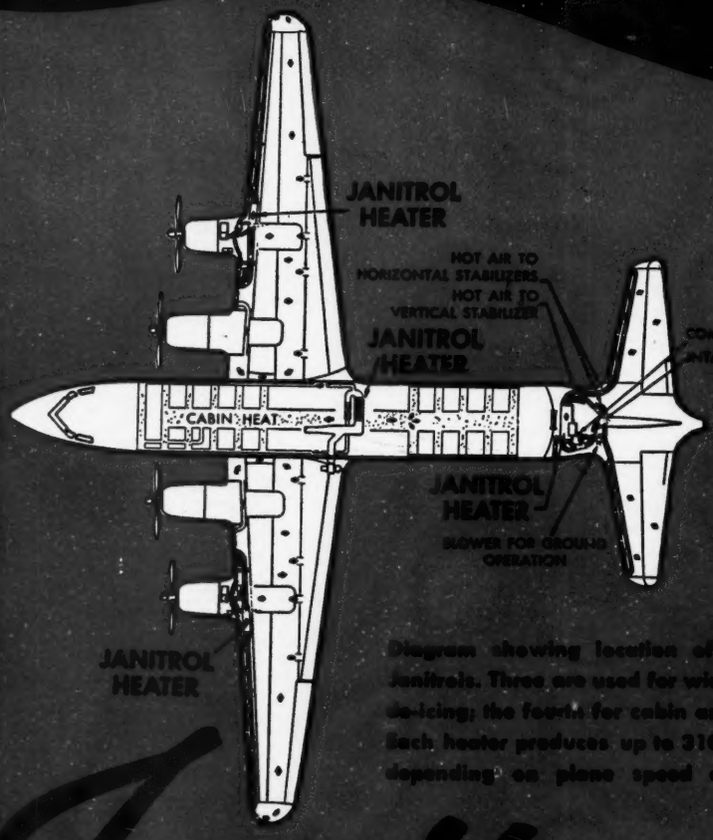
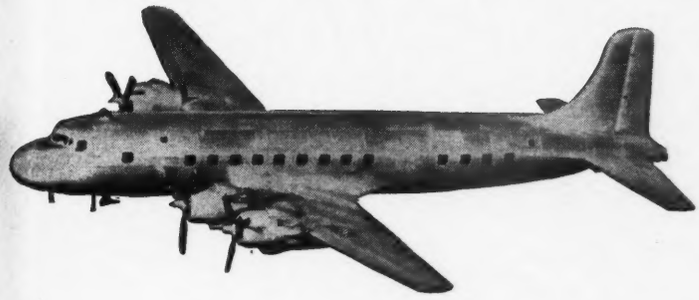


Diagram showing location of each of the four Janitrols. Three are used for wing and empennage de-icing; the fourth for cabin and cockpit heating. Each heater produces up to 310,000 Btu per hour, depending on plane speed and other factors.

Janitrol

AIRCRAFT HEATER DIVISION • SURFACE COMBUSTION COR



IN planning for the very finest possible passenger comfort and safety, Douglas engineers called upon Surface Combustion to meet the most exacting specifications ever set by an aircraft manufacturer.

Here are some of the outstanding advantages of the Douglas system, and how they are achieved:

No Cold Floors Nor Walls—Cabin is heated by a single Janitrol installed below the floor. Warm air circulates beneath cabin floor, up through the side walls and out through recessed grilles above passengers. Result is a unique combination of radiant and circulating warm air heat.

Reliable Thermal Ice-Prevention—Three of the four Janitrols in the Douglas DC-6 are used for tail and wing de-icing. A Janitrol located in each wing provides hot air circulation through the leading edges of the wings. One Janitrol in empennage heats all tail surfaces subject to ice formation.

Complete Year 'Round Air Conditioning—Constant, comfortable 70° F. cabin temperatures are accurately maintained even with outside temperatures as low as —40° F. In warm weather the refrigeration unit in duct system provides air cooling.

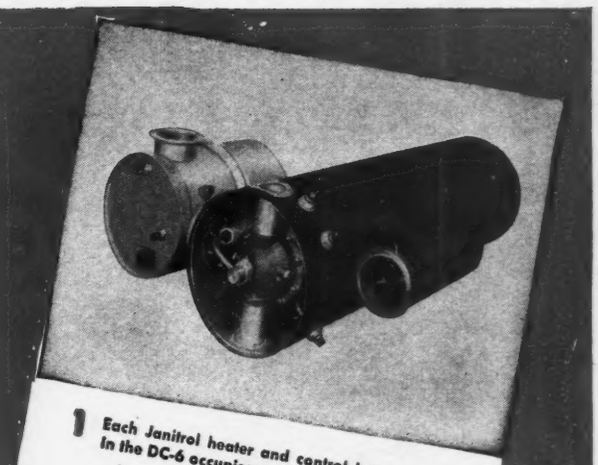
Dependability—Two complete sets of heater controls assure dependable operation which could otherwise be gained only by duplicating the weight and space required for the entire heating system. Proven dependability of Janitrol makes duplication of the heater unnecessary.

Safety—Ignition, fuel, air, and pressure regulators, and filters are located in one explosion-proof housing. Provision is made for flooding the housing and heater with CO_2 in case of fire.

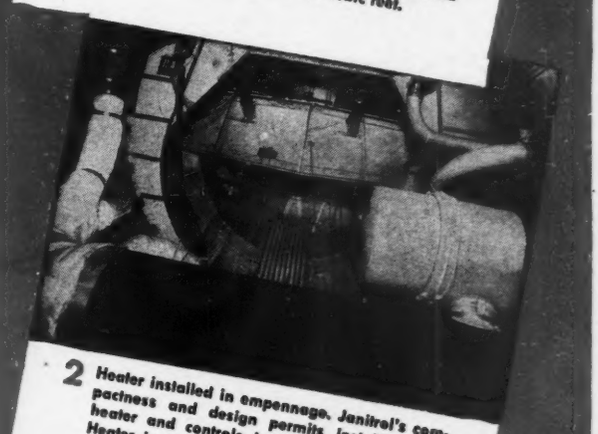
Janitrol construction principles insure against contamination of ventilating air by products of combustion. Ventilating air is supplied by cabin pressurizing supercharger. Combustion air is from ram.

Ease of Maintenance—Control assemblies for each Janitrol heater may be changed in 5 minutes. All critical parts are easily accessible. Maintenance repairs are infrequent because Janitrols often provide 1000 hours of service without major attention.

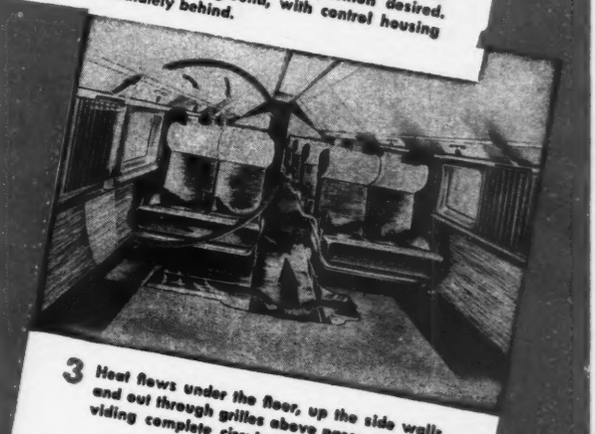
But That's Only Part of the Story! For more information on how Janitrol Whirling Flame Heaters meet the requirements for the DC-6, and to learn how Janitrols can help solve *your* aircraft heating problems, write Surface Combustion Corporation now.



1 Each Janitrol heater and control housing used in the DC-6 occupies only 3½ cubic feet.



2 Heater installed in empennage. Janitrol's compactness and design permits installation of heater and controls in any position desired. Heater is in foreground, with control housing immediately behind.

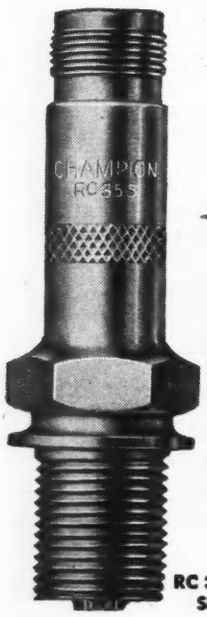


3 Heat flows under the floor, up the side walls, and out through grilles above passengers, providing complete circulation and ventilation.

4 Douglas DC-6 passengers will enjoy complete heating comfort and year 'round air conditioning in pressurized cabins, regardless of outside temperatures.

CORPORATION • TOLEDO 1, OHIO

Here's why Chicago and Southern specifies Champion Spark Plugs



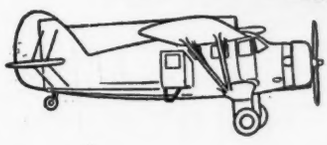
RC 35S actual size
Shielded type

THEY'RE DEPENDABLE!

Absolute dependability is the ultimate criterion in spark plugs as in everything else used by the airlines. That's why it's noteworthy that Chicago and Southern, like the majority of airlines, standardizes on dependable Champion Spark Plugs. Here is substantial evidence your own aircraft engine, whatever its size, will run more dependably with Champions. Champion Spark Plug Company, Toledo 1, Ohio

C26—
actual size 2-⅛"
Unshielded type

INSTALL CHAMPIONS AND FLY WITH CONFIDENCE



NORSEMAN CONVERSION

Special facilities are available for the conversion of the Norseman C-64 military type to peacetime use. Enquiries are solicited.

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CBY-3 CARGO TRANSPORT

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All rights for the manufacture, sale and service of the NORSEMAN aircraft have been acquired by CANADIAN CAR & FOUNDRY COMPANY, LIMITED, MONTREAL, CANADA

Operators of the Norseman V are advised that complete service, parts and conversion facilities are now provided at the St. Laurent Plant of Canadian Car & Foundry Company, Limited, Montreal, Canada, where expert aircraft personnel will give your requirements prompt and efficient attention.

As a result of redesign of components and elimination of fixed provisions for military equipment, weight reduction of the Norseman V permits approximately 25% increase in payload, as compared with the military type, C-64.

The addition of the multi-purpose, single engine NORSEMAN, formerly manufactured by Noorduyn Aviation Limited, marks another step in the development of Canadian Car's Aircraft Division. Together with the new Burnelli type CBY-3 twin engine cargo transport plane, the prototype of which is undergoing flight trials, this company will be equipped to serve main and feeder airlines in both passenger and cargo operation.

The Canadian Car Aircraft Division in addition offers expert instrument service for all types of aircraft instruments; is the sole manufacturer of hydraulic controlled aircraft propellers in Canada, and has recently developed a new type of variable pitch propeller for light aircraft within the personal plane field.

Write for full particulars, performance data, and illustrated catalogue of the Norseman V.

Write for the illustrated brochure on the new CBY-3 Burnelli type cargo transport.

CANADIAN CAR & FOUNDRY COMPANY, LIMITED

Aircraft Division

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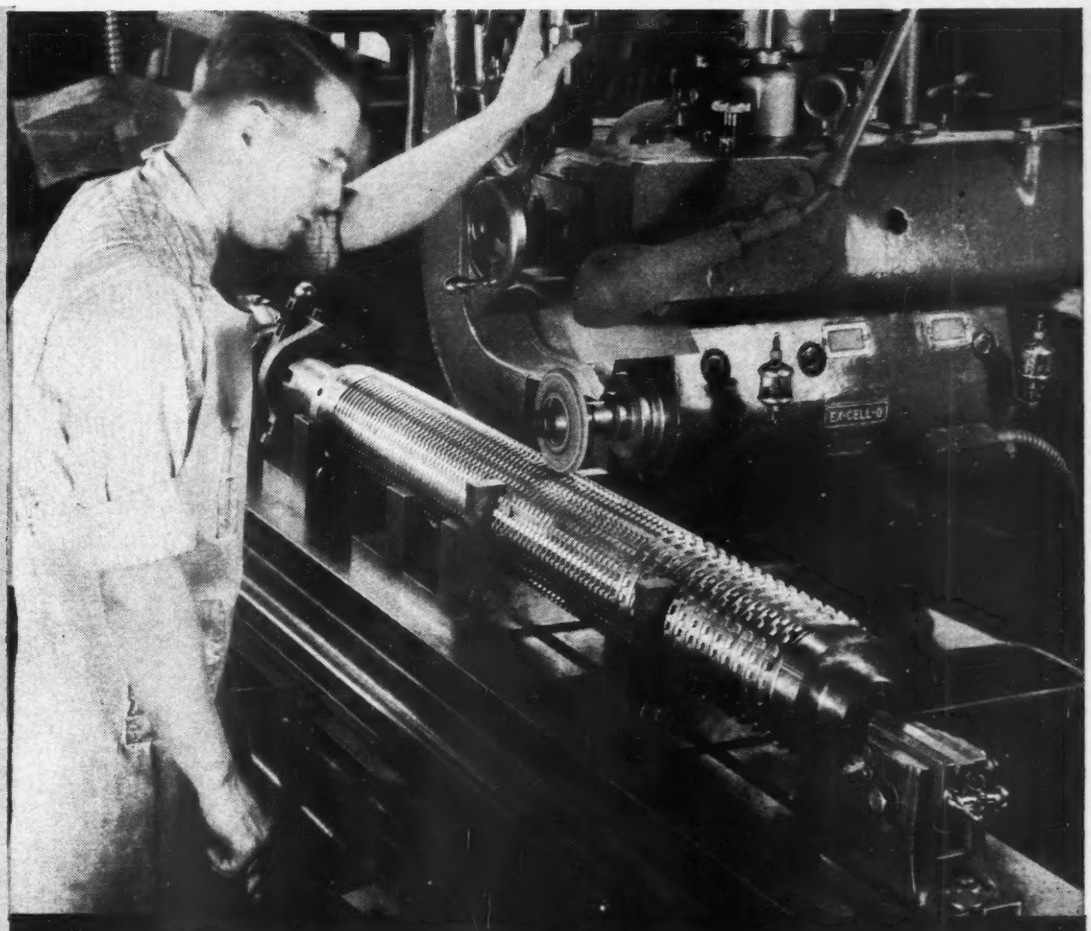

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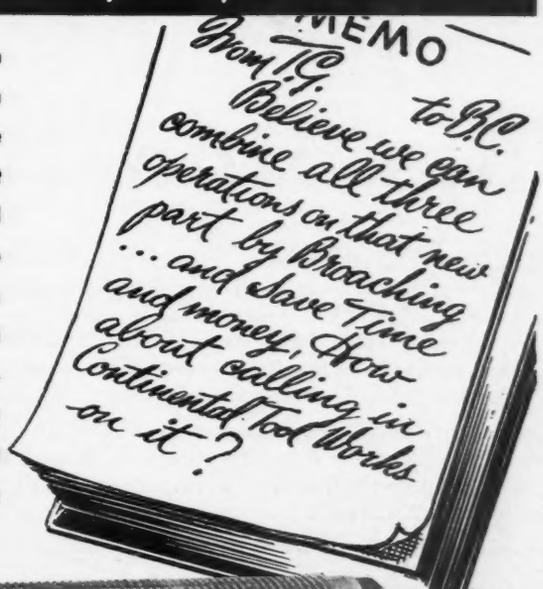
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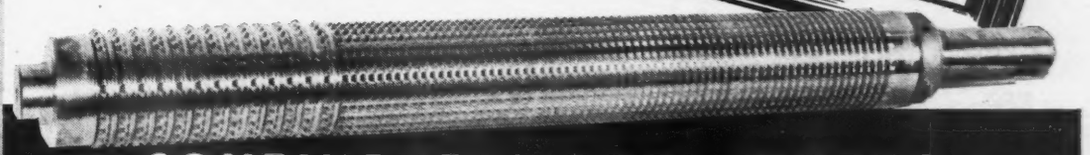

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a vital contribution to

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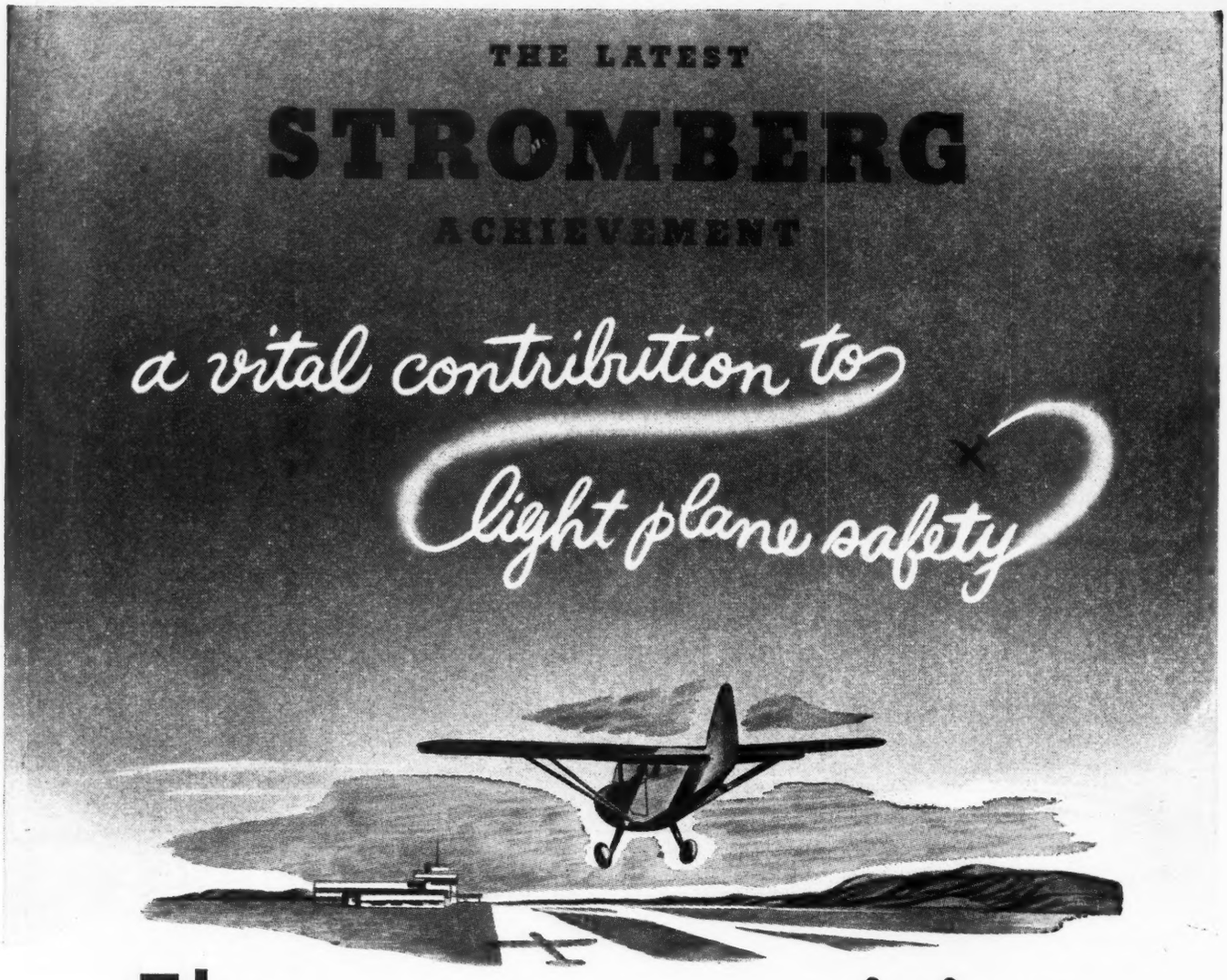

The new non-icing injection-type carburetor

The new Stromberg* PS Series Injection Carburetor eliminates internal carburetor icing caused by the refrigerating effect of fuel vaporization. This important safety feature results from spraying the fuel into the air stream as it leaves the carburetor and enters the engine manifold, instead of the usual practice of discharging the fuel by venturi suction within the carburetor.

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Stromberg PS Series Carburetors are a light-plane adaptation of the principles of the Stromberg Injection Carburetors which were practically universal equipment on wartime airplanes. Regular equipment includes a vacuum-operated accelerating pump and a combination mixture control and idle cut-off. Automatic mixture control and power enrichment features are optional. Built in six sizes, for engines ranging from 50 H.P. to 500 H.P.

It will pay you to look into the extra performance and safety of Stromberg Carburetion as original factory equipment for light planes. An interesting descriptive folder will be sent upon request.

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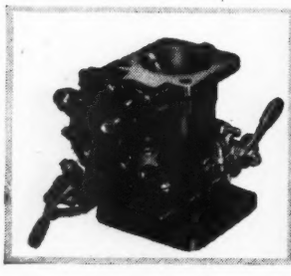

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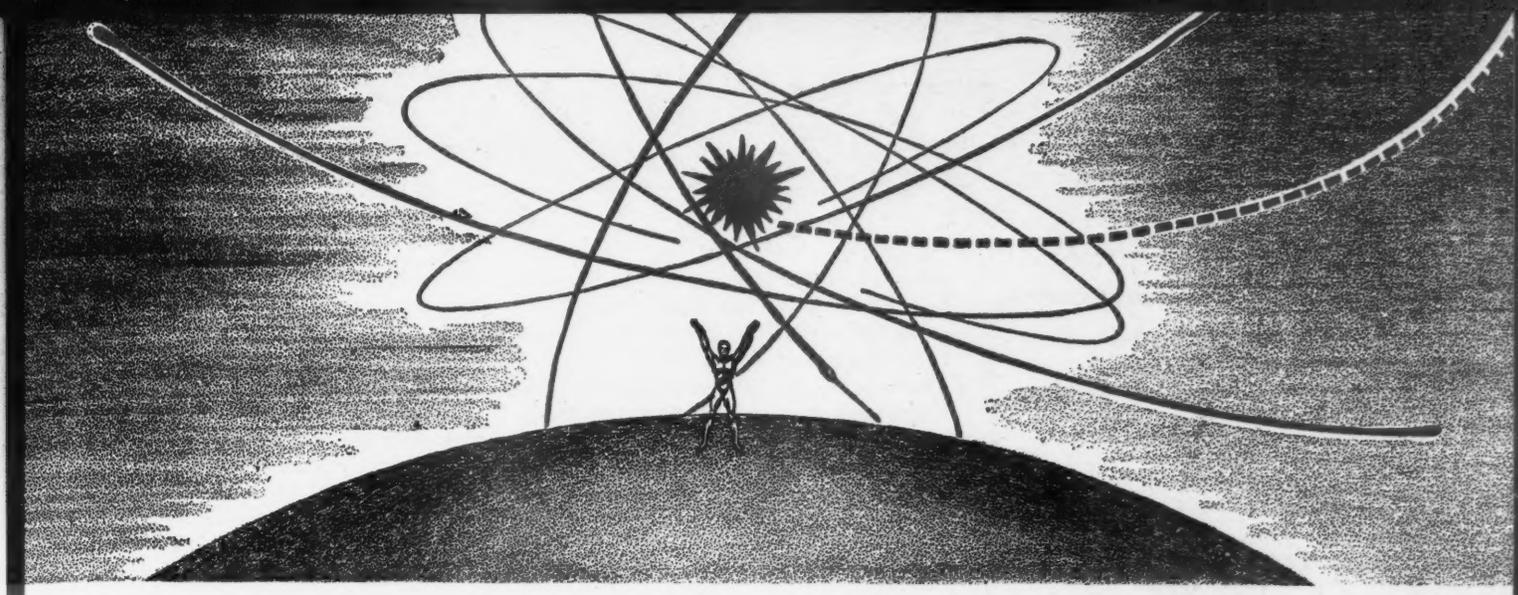

MAN vs ATOM—YEAR 1

WHEREIN WE SIGNALIZE THE FIRST ANNIVERSARY OF THE ATOMIC AGE, CONSIDER THE ALTERNATIVES INHERENT IN BOTH GOOD AND EVIL POTENTIALITIES OF NUCLEAR FISSION, THEN VENTURE A GLIMPSE INTO THE FUTURE

A YEAR AGO, July 16, 1945, at Alamogordo, New Mexico, man created the first atomic explosion. Most impressive events diminish in stature as they recede in time. This one grows bigger with each passing day. It truly marked the beginning of a new age.

As Year 1 of the Atomic Age ends and Year 2 begins, we are engaged in three portentous projects.

At Bikini Atoll we are detonating the fourth and, possibly, the fifth atomic explosions in the history of the world.

At Oak Ridge, Tennessee, we are building the first atomic energy plant for peaceful purposes.

Most important, in New York we and all the other United Nations are engaged in the first attempt to subject atomic energy to international control. Literally, the fate of the world hangs on this attempt.

As this introduction is written, the United Nations Atomic Energy Commission has just begun its work. People everywhere pray for its success—for their own sake, but even more for their children and for their grandchildren. If this Commission fails let everyone everywhere be warned: the world has taken a step toward destruction.

As we enter the second year of the Atomic Age, the nations of the earth are embarked on an atomic armaments race. There is no blinking that fact. We have had official notice served on us. Therefore, we must understand that unless the United Nations Commission can arrest the drift of events, we are moving toward a horrible war. The Commission must succeed.

The American delegate, Mr. Baruch, has brought to the Commission an ably thought out plan. It would internationalize nuclear science, and release for mankind the beneficent applications of atomic energy. But it would "control" atomic bombs only to the extent of giving the world brief warning of any nation's preparation to use them, so that we might have foreknowledge of disaster.

Therefore, the real and enormous task before the world becomes clear. We must end war. No other control of atomic weapons exists. If war comes, atomic weapons will be used. If they are used, our children who survive will curse their fathers. Understanding the consequences of failure, we *must* succeed.

Because we cannot succeed without knowledge, I have asked my associates at McGraw-Hill to condense into the following pages what we know at the close of Year 1 about this great new atomic force — its basic science, its possible uses and its political repercussions.

James H. McGraw, Jr.

President, McGraw-Hill Publishing Co., Inc.

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This Fateful Atom...

LOOKING BACK twelve months to the birth of Year 1, Atomic Age, we begin to sense the majestic import of the atomic bomb that blasted the naked desert at Alamogordo, N. M., on July 16, 1945. There man first shattered atoms in an explosive *fast-chain* reaction. Then came Hiroshima and Nagasaki.

In every case the fateful atom was either uranium 235 (U235), or plutonium derived from the action of U235 on U238. Every pound of U235 atoms split in these unprecedented blasts yielded the energy of 11.4 million kilowatt-hours, or 1400 tons of coal — slightly more for plutonium.

No matter where one mines uranium ore, the purified natural uranium (Fig. 1) always contains 99.3% of the "garden" variety U238, and a mere 0.7% of the precious U235.

An atom is like our solar system. The central sun is the nucleus — a bunched mass of protons and neutrons, each weighing one unit. The planets are electrons. Each proton has one plus electrical charge — each electron an equal negative charge. There must be as many negative electron planets as positive protons in the nucleus. This is also the "number" of the atom. Neutrons have no charge, but add weight.

The atomic number of uranium is 92 because the uranium atom always has 92 nuclear protons and 92 electron planets. The isotopes U238 and U235 differ only in the number of neutrons; U238 has 146 neutrons, and weighs 92 + 146 = 238 units. U235 has 143 neutrons, and weighs 92 + 143 = 235 units.

Ordinary chemical reactions, such as TNT explosions, release only a fraction of the modest energy of the whirling electrons in the outer atom. Nuclear reactions unlock the immensely greater energies which bind together the nucleus.

Even the gentle tap of a slow-moving neutron bullet will split the atom of U235 or of man-made plutonium into two medium-weight atoms, yielding also one to three spare neutrons plus energy. Thus these *fissionable* materials supply both their own bullets and a highly sensitive lot of high-explosive targets — a perfect setup for a *chain reaction* (Fig. 2).

Chain reactions work like chain letters. Neutrons from one nuclear explosion hit and explode other nuclei. But, since atoms are mostly open spaces a chain started in a small block of U235 or plutonium quickly dies out because most of the released neutrons escape from the block.

The bigger the block, the smaller will be the percentage of escaping neutrons, and the more left to split other nuclei. When the block is rapidly built up beyond a certain secret size the fragments of 1000 nuclear fissions split many more than 1000 additional nuclei. Then fissions multiply geometrically, and the block disintegrates with explosive speed and violence — as in a bomb (Fig. 3).

This bomb explosion is a fast-neutron chain. For economy and ease of control, uranium piles for the gradual release of nuclear energy for commercial purposes will normally use a lean fuel — that is U235 or plutonium diluted with U238, thorium or other less costly materials.

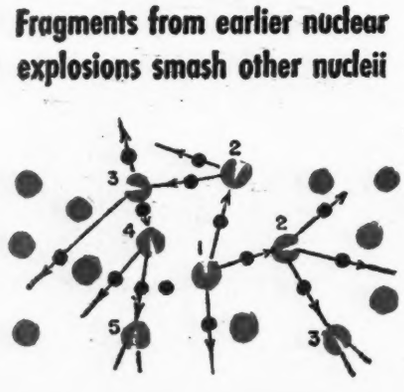
To maintain a chain reaction such piles must be large and artificially stimulated by using carbon blocks or some other *moderator* (Fig. 4) to slow many of the neutrons. Slow neutrons make more hits than fast neutrons because there is more time for them to be swerved from a straight path by the attraction of nearby nuclei, as shown below.

1 ORE TO U235

Only 0.7% of natural uranium is U235

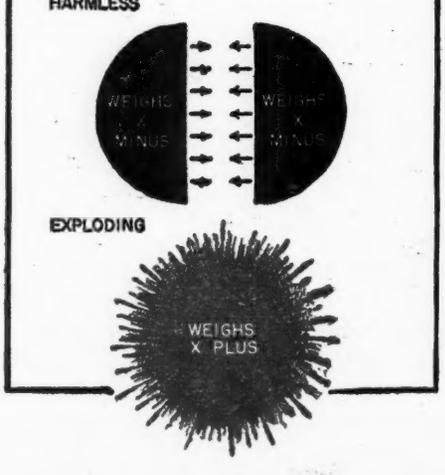
2 CHAIN REACTION

Fragments from earlier nuclear explosions smash other nucleii



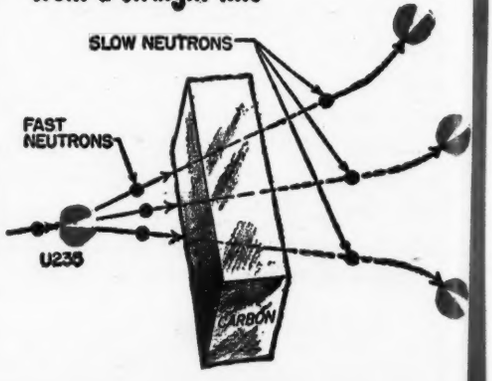
3 WHY BOMB EXPLODES

When block of rapidly assembled U235 passes secret critical size it explodes spontaneously



4 SLOW NEUTRONS MAKE MORE HITS

A slow neutron is more easily swerved from a straight line



...can Serve Man...

THE FATEFUL U235 ATOM can serve man as a new, compact source of heat energy for power generation, comfort heating or industrial processing. Peacetime applications of atomic energy will use dilute U235 or plutonium as a "fuel," mixed with carbon or some other moderator to slow some of the neutrons and thus keep the chain reaction going.

The diluting agent may be either U238 or thorium, or both. These will do double duty, because neutron bullets convert U238 into the energy-yielding plutonium, and thorium into U233, which may prove equally serviceable.

Thus the commercial piles of the future will "burn" U235 to make other atomic fuels, plutonium and possibly U233, which in turn will deliver heat energy to the pile. In that way it will be possible to get from the pile far more heat than the equivalent of 1400 tons of coal for each pound of U235 split. This highly attractive prospect will speed the day when nuclear energy can compete with coal.

While already mechanically obsolete, the piles making plutonium for bombs at Hanford, Wash. (Fig. 1) reveal the basic principle on which future piles for power and heat will operate. The heat now wasted in vast quantities will be put to work. The plutonium, now removed for bomb manufacture, will be returned to the pile (or left in) as supplementary fuel.

ATOMIC POWER

The possible everyday applications of nuclear heat pictured in Fig. 2 have been recognized from the very first day of the Atomic Age. Year 2 will see the building of the world's first atomic power plant (a pilot plant) at Oak Ridge, Tenn.

Beyond question such installations will produce power, but it may be years or decades before they prove economical. To compete with conventional plants the piles must first be redesigned to run at temperatures high enough for good power-plant efficiency. Also the techniques of operating piles by remote control through the heavy radiation screens must be radically streamlined.

The Hanford piles run on natural uranium containing only 0.7% of U235. The typical commercial atomic power plant of the future will use more than 0.7% of U235 or plutonium, but less than 50%. This will avoid both the low efficiency of the too-lean mixture and the excessive fuel cost of the rich mixture. It will permit piles of moderate size and take maximum advantage of U238 and thorium as potential sources of plutonium and U233.

One should not expect U235 to replace coal generally in this generation, although a few central power stations and ships will try it out before Year 10 of the Atomic Age. Plants far from traditional sources of fuels may turn much sooner to uranium and thorium as concentrated heat sources, that may easily be transported even to remote corners of the earth.

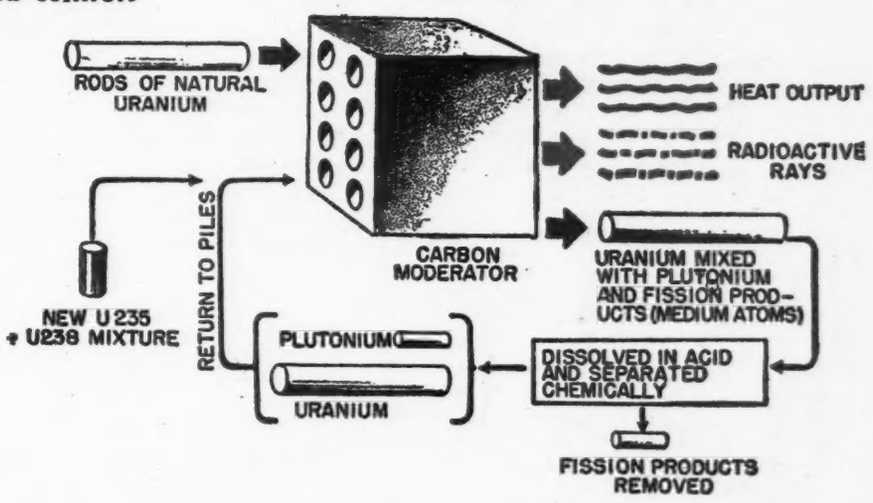
Atomic power, in forms now known, is impracticable for automobiles and small airplanes, because of the large initial investment in uranium and the need to carry 50 tons of shielding to protect riders and pedestrians against the deadly radioactivity accompanying nuclear fission.

RADIOACTIVE ISOTOPES

More immediately important than the heat and power applications of nuclear energy are the services that the radioactive byproducts of pile operation can render. Because these materials act chemically like their ordinary non-radioactive cousins, but can be followed and detected easily, they are expected to play tremendously vital parts in medicine and biology. For more details, see the last page of this section.

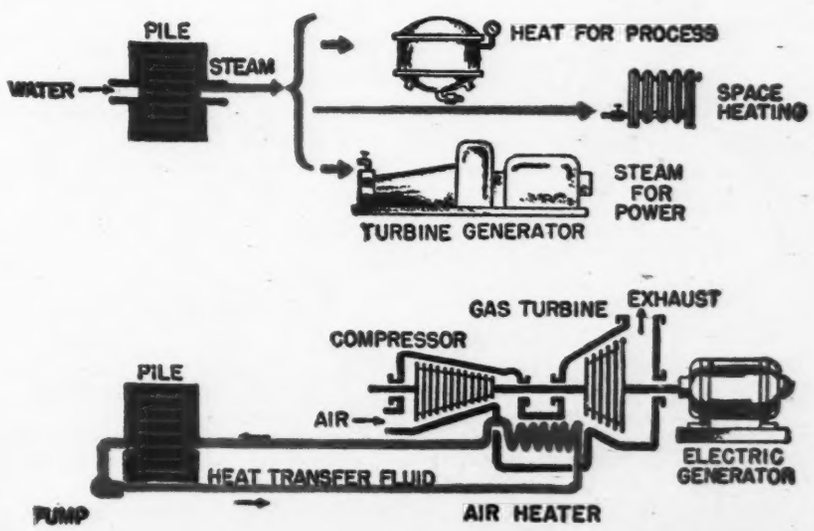
1 SLOW-NEUTRON PILE

Can make plutonium for bombs—or heat for power, process and comfort

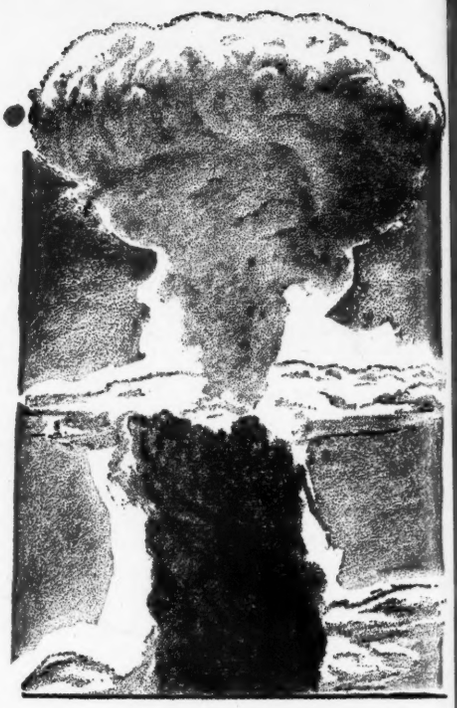


2 PRACTICAL APPLICATIONS

Include steam for turbines, process and comfort heating—also heat for gas turbines



or Destroy him . . .



A single improved atomic bomb can devastate ten square miles of city

URANIUM 235 and plutonium are now man's slaves. They will build or destroy as he orders. Man dreads this vast force only because he distrusts himself. War is proof that man in the mass has never achieved self-control. He has always sought better weapons; yet the perfect weapon now brings him no satisfaction for he sees in the atom bomb his own destruction as well as that of his enemy.

The ultimate benefits of nuclear energy may well surpass its present terrors, but the terrors are here now in awful dimension, and man must face them. He must pay this price for unlocking the wealth of the inner atom.

ATOMIC BOMB

This page, then, is about the atomic bomb. Nothing will be said here that is not either a certified scientific fact or a conclusion shared by the majority of the leading scientists, engineers and statesmen who have studied the matter.

As already explained, an explosive nuclear chain reaction spontaneously sweeps through a block of U235 or plutonium when the block is rapidly enlarged beyond a certain "critical" weight X. That weight is still a military secret; the official Smyth report vaguely suggests that it is more than 4 lb and less than 200 lb. Each piece of U235 in the dormant bomb must weigh less than X. At the desired instant of explosion the bomb mechanism assembles these pieces rapidly into a single piece considerably heavier than X.

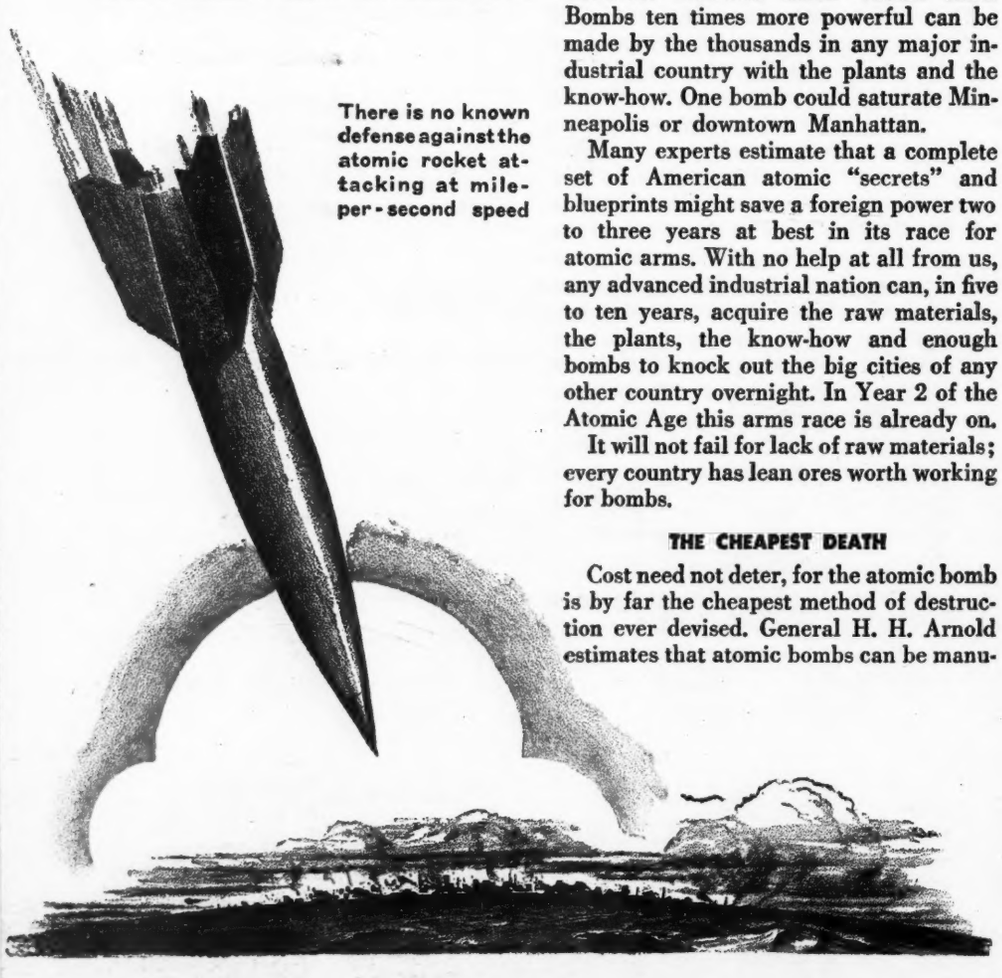
The explosion itself drives the U235 pieces apart, thereby quenching the atomic conflagration before all the atoms are split, so the bomb efficiency is far less than 100%. For each pound of U235 (or plutonium) atoms actually split, the bomb releases the energy of 1400 tons of coal.

This explosion is mainly ordinary heat at work in unprecedented concentration. Bomb metals become incandescent vapor millions of degrees hot. This, and the enveloping sphere of glowing air, radiate a blinding flash that chars human flesh at half a mile and blisters at over a mile. There is a destructive shock wave (sound) and a second-long hurricane of unimaginable force — the outrushing of the expanding heated air. Deadly neutrons and gamma rays speed out from the bomb.

A single atomic bomb killed about 100,000 at Hiroshima. Fewer died at Nagasaki only because the circle of potential destruction included much vacant land. Bombs ten times more powerful can be made by the thousands in any major industrial country with the plants and the know-how. One bomb could saturate Minneapolis or downtown Manhattan.

Many experts estimate that a complete set of American atomic "secrets" and blueprints might save a foreign power two to three years at best in its race for atomic arms. With no help at all from us, any advanced industrial nation can, in five to ten years, acquire the raw materials, the plants, the know-how and enough bombs to knock out the big cities of any other country overnight. In Year 2 of the Atomic Age this arms race is already on.

It will not fail for lack of raw materials; every country has lean ores worth working for bombs.



There is no known defense against the atomic rocket attacking at mile-per-second speed

THE CHEAPEST DEATH

Cost need not deter, for the atomic bomb is by far the cheapest method of destruction ever devised. General H. H. Arnold estimates that atomic bombs can be manufactured *and delivered* for less than $500,000 per square mile of destruction.

Don't be misled by the two billion dollars America spent on a project that dropped only two bombs on the enemy. New plants can be built at a fraction of wartime cost, and the investment spread over thousands of bombs, not just two.

NO DEFENSE

So the bombs can be made in ample quantity and paid for, but can they be delivered? The answer is: "Yes; by the time the bombs are ready they can be delivered anywhere and overnight." If the defenses of the target country are weak, piloted planes can get through in ample number. Ten percent would be enough.

For more effective delivery radio-steered pilotless planes and rockets can carry the atom bombs faster than sound. Such weapons will be almost untouchable by either antiaircraft artillery or manflown fighters.

Greatest threat of all will be the transoceanic rockets. The German V-2 rocket, which never once was stopped by Britain's defenders, points one way. It needs only transatlantic range (with atomic propulsion) and an atomic bomb in the nose. Forty-six feet long, loaded with 7500 lb of alcohol fuel and 11,000 lb of liquid oxygen, the V-2 of World War II rose 60 miles in the air and arced 200 miles in five minutes to deposit one ton of TNT in London.

Seeing so many strange things come to pass, the man in the street cannot distinguish between possible miracles and the impossible variety. From the very start of the Atomic Age he has been hoping for a "ray" that will explode the atom bomb far off. Competent scientists and engineers say that cannot be.

The only way to bring down a 3500-mile-per-hour rocket at a safe distance is to chase it with your own 4000-mph rocket. You can't win at this game often enough to establish ironclad protection.

The only specific defense against the atomic rocket known in Year 2 of the Atomic Age is to disperse all cities and put key industries underground. This would be very costly in time, money and national morale.

MORE AND BETTER BOMBS?

Some will ask whether the U.S., as the most powerful industrial nation, could not build more and better bombs and carriers than any other nation. Probably yes, but there is still no real security. If the "weak" opponent has enough atomic weapons to destroy us once, what advantage is there in being able to destroy him twice?

Shooting first could protect us now, but not after the world is atomically armed. If we were to destroy the enemy's cities, we would probably miss his well-concealed and protected bomb magazines and rocket launchers. A few minutes later he could return the atomic fire. In brutal simplicity, that is the picture of future atomic war. Everybody loses.

At this point one grasps at another straw: "If everybody is to lose who would be so foolish as to start an atomic war? And didn't the Germans refrain from using gas for a similar reason?" Possibly yes. It *may* work that way. But in a world atomically armed to the teeth some nervous finger *may* pull the fatal trigger.

ONLY ONE WAY OUT

Throughout history each new offensive weapon has called out its appropriate defense. But now the offense leaps centuries ahead in a single bound and the defense lies almost helpless everywhere, unless some technical protection, unknown as Year 2 begins, can be devised.

The situation is extremely dangerous. There is no clear way out except through some sort of international action first to stop the atomic arms race and, before it is too late, to hobble war itself.

Can it be done? Perhaps not, but there is no alternative except atomic chaos.

...so he faces the Atomic Dilemma...

THE NUMBERED statements that follow in somewhat logical pattern are too fateful to be accepted on anybody's say-so. Every reader should test them in the light of his own information and understanding.

The points below sum up the conclusions of the previous article — and these in turn reflect a great mass of thought and discussion among leading scientists, engineers and statesmen close to the problem. To an amazing degree they concur on both facts and conclusions. For authoritative statements of their line of thought, in detail not possible here, the reader should see the recent book, *One World or None.*

THE DILEMMA

Nations must either face the probability of an atomic World War III, which would surely be the most deadly in history . . .

***Or,* the experts propose, yield both atomic weapons and war potential to international authority backed by superior force.**

What the Experts Say

1. In five to ten years any major industrial nation can make enough atom bombs to destroy all the major cities of any other country overnight.

2. This assumes no "secret" information or other help from us.

3. The necessary uranium ores will be at hand.

4. The cost will not be too high.

5. The bombs produced can then be carried thousands of miles by bombers, or by atomically powered guided missiles moving faster than sound.

6. There will probably be no effective military defense against such weapons.

7. Dispersing cities, and putting key industries deep underground, will give some protection if accomplished in time, but at incredible cost in money and human discomfort.

8. In a world atomically armed, nations can probably protect their bomb stocks and rocket launchers from enemy assault.

9. If so, nation A can destroy the cities of any other nation B, after which B's rockets will destroy the cities of A. Shooting first will not win an atomic war.

10. This knowledge may not restrain the trigger finger of a suspicious power.

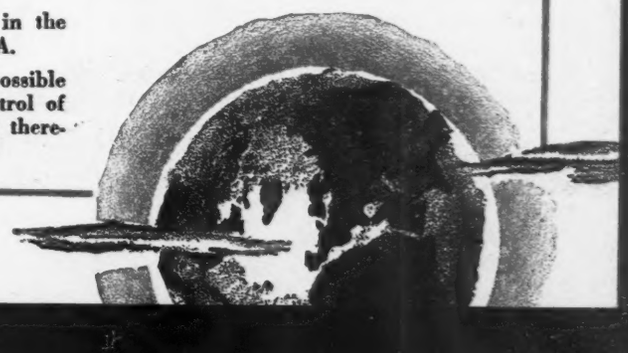
11. Having more and better atomic weapons than the other fellow won't help much if he has enough to destroy us. No use to kill a man twice or rebomb urban ruins.

12. Every nation is vulnerable in the Atomic Age, including the U. S. A.

13. National security will be impossible without (first) international control of atomic arms and (not too long thereafter) international control of all war potential, both backed by superior physical power.

14. If action to this end is long delayed, it may become impossible to halt the atomic arms race already started.

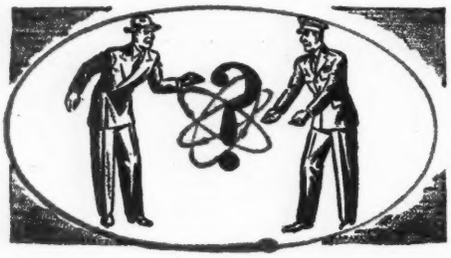
15. At best, the necessary degree of international control, with some real delegation of national sovereignty, will be a revolution in human affairs. It may prove to be humanly unobtainable at this time. If so, men and women everywhere must face the probability of an atomic third world war—by far the most destructive in all history.



In this atomic age no nation can be safe through its own unaided might

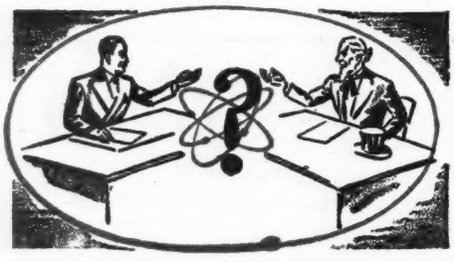
..and the Great Debate unfolds

ATOM YEAR 1 has probably been marked by more debate on a single subject than any other twelve months in the world's history. Social, economic and political as well as purely technical issues have been pressing for realistic solution. Let us look at these issues and see where we stand:



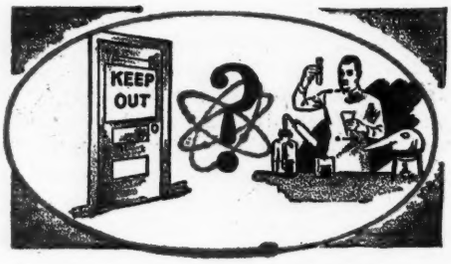
CIVILIAN VS. MILITARY

Because the atomic bomb is the world's greatest weapon, the armed forces would like to control it. But because atomic energy can also be used for peaceful, beneficial purposes, civilian control seems equally essential. These conflicting viewpoints had their strong proponents before the Congress which finally reached a fairly satisfactory compromise in the Atomic Energy Bill of 1946, setting up a competent civil board with which the armed forces will have continuing liaison. As we go to press, just before Year 2 of the Atomic Age begins, this bill has passed the Senate, but there is still a question how rapidly it will be enacted into law.



PRIVATE VS. PUBLIC

Atomic energy is "too big" and "too hot" to be handled privately. It must be nationalized and internationalized. The questions are *how* and *to what extent.* Fortunately, as the "boxes" on these pages show, there are means that may attain reasonable safety against misuse of the atom, and still do so without public control of many "non-dangerous" applications.



SECRECY VS. FREE SCIENCE

Throughout the first year of the Atomic Age hot debate has raged around "keeping the secret of the bomb." To prevent potential enemies from making atom bombs some have urged a complete blackout of all phases of atomic energy — even of the scientific fundamentals of nuclear physics. Others have sought immediate and complete disclosure of all bomb "secrets," both scientific and technological. These have held that such information cannot be effectively hidden, that secrecy blocks progress and breeds wars.

A year of debate has brought the great mass of vocal opinion to this middle ground: (1) Ease restrictions on the exchange of basic physical knowledge. (2) Release for industry's benefit many of the devices and methods developed for the bomb project. (3) Hold tight to specialized information on atomic bombs and bomb-material production until international safeguards are fully operative.

DOMESTIC CONTROL AS PLANNED IN THE ATOMIC ENERGY BILL OF 1946

McMahon Committee Bill contains the following provisions.

Policy. Declares it the policy of the U. S. to develop and utilize atomic energy to improve the public welfare, increase living standards, strengthen competitive enterprise and promote world peace.

Organization. Establishes the Atomic Energy Commission (AEC) of five administrators to direct four divisions on research, production, engineering, and military applications—to work in liaison with three committees from (1) the armed forces, (2) outstanding civilians, and (3) joint Congressional representatives.

Production. AEC to own and operate (under management contracts with industry if deemed desirable) all facilities for the production of fissionable materials, such products to be distributed with their radioactive byproducts under license for private industrial and medical research.

Military Application. AEC to engage in development work and produce atomic bombs as directed by the President, to be delivered only on his order to the Armed Forces.

Industrial Utilization. Permits AEC to conduct research, design and manufacture equipment for atomic-energy utilization, license its use, produce and sell power obtained as a byproduct in the production of fissionable materials. Directs AEC to give widest safe scope to private initiative.

Control of Information. AEC to enforce a ban on the dissemination of restricted data that might be used to injure the U. S. or secure advantage to a foreign nation, yet to provide leeway for ultimately relaxing restrictions as future conditions warrant.

Patents and Inventions. No private patents permitted for production of fissionable materials or their utilization for military weapons, but AEC will justly compensate for such inventions, when made by private citizens. Patents for non-military applications may be purchased or condemned by the AEC only when public interest is affected.

Appropriations. "Such sums as may be necessary and appropriate to carry out the purposes and provisions of the act" *plus* unexpended funds of the Manhattan Engineer District.

...while Time runs out

NATIONAL VS. INTERNATIONAL

Born of nationalism, the Atomic Age began when three nations discovered a weapon that today gives them the greatest military power on earth. The prime question is: Shall the atom remain the servant of its conqueror, nationalism?

During Year 1 of the Atomic Age the Truman-Atlee-King declaration, the masterly report of the State Department's atomic consultants, and the U.S. representative on the United Nations Atomic Energy Commission, have all called for international control of atomic energy. Year 2 will start with no such control. This failure to decide and act is in part a natural result of the extreme difficulty of the problem and the obvious dangers of unwise decisions. Nations everywhere face a triple dilemma in this Atomic Year 2: the dangers of nationalism, the dangers of internationalism, the supreme danger of not being able to make any decision in time to meet the atomic bomb threat.

INTERNATIONAL CONTROL AS PROPOSED BY THE U.S. TO U.N. ATOMIC COMMISSION

Baruch statement follows constructive path laid out by Atomic Consultants in "Acheson-Lilienthal Report."

The Plan. The U.S. has proposed that all nations band together to outlaw the use of atomic energy for war and to promote and harness its development for the benefit of mankind. To this end an International Atomic Development Authority would be set up, and to it the U.S. would turn over, at various stages of its organization, all atomic bombs, know-how, raw materials, facilities, and stockpiles of fissionable material. Thus IADA eventually would supersede national authorities on some matters and supplement them on others.

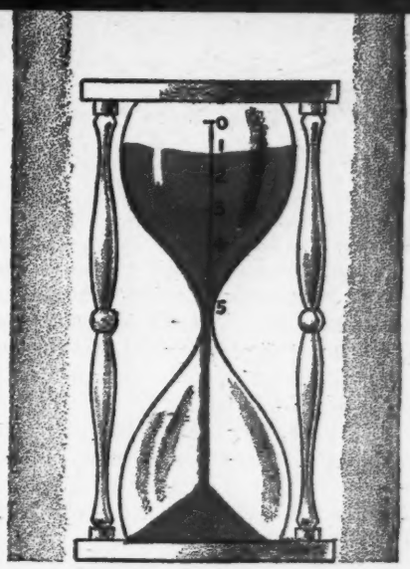
Owner and Operator. IADA would take over from national authorities or private ownership full management and control of all atomic energy matters that afford a possible threat to World security. These include:

1. Raw Materials—Supplies of uranium and thorium to be inventoried, controlled, and developed by IADA.
2. Facilities—IADA to control and operate plants producing fissionable materials and to own and control their products.
3. Research—IADA to undertake research and development on all aspects of atomic energy and to possess exclusive right of research on atomic explosives.

Private Initiative. Will have its chance to push forward the use of atomic energy for peacetime (non-dangerous) purposes. With IADA providing raw materials and carrying out necessary inspection, national and private enterprise may operate "safe" power piles, and produce and use radioactive isotopes for research, clinical and other applications. Radioactive isotopes produced by IADA also can be distributed for peacetime use.

The Mechanics of Safety. No plan is a certain guarantee against future atomic war. This plan should, however, prevent surprise attack with atomic weapons; for IADA is to buttress positive ownership or management controls with wide powers of inspection. Obviously, successful inspection rests on complete freedom of access or egress in any area.

Sanctions. At the heart of the plan lies the problem of penalty for violation — a matter for profound statecraft. To the U.S., one aspect of sanctions appears crystal clear: Here is an area where the veto right now held by the five great Powers must be redefined if it is not to be incompatible with the meaning and purpose of the proposed control.



Leading industrial nations can produce atomic bombs in five years, competent scientists announced after Hiroshima. Already one year of the precious five has been consumed in debate without international action. Soon it may be too late to check the growing momentum of the atomic arms race.

TIMETABLE—ATOM YEAR 1

1. **July 16, 1945.** World's first atomic bomb detonated in New Mexico.
2. **July 26, 1945.** President Truman and Prime Minister Churchill issue Potsdam ultimatum threatening Japan's destruction if she continues.
3. **August 6, 1945.** Atomic bomb dropped on Hiroshima.
4. **August 9, 1945.** Atomic bomb hits Nagasaki.
5. **August 11, 1945.** Army releases Smyth Report on "Atomic Energy for Military Purposes."
6. **August 14, 1945.** Japan accepts terms of Potsdam declaration.
7. **November 15, 1945.** Truman-Atlee-King issue declaration of intention and procedures looking toward international control of atomic energy by United Nations.
8. **March 28, 1946.** State Department issues Acheson-Lilienthal Report on the "International Control of Atomic Energy."
9. **April 12, 1946.** Manhattan Engineer District announces program for experimental development of atomic power.
10. **June 1, 1946.** "Atomic Energy Bill of 1946" passes Senate unanimously, is referred to House of Representatives.
11. **June 14, 1946.** First meeting of United Nations Atomic Energy Commission (Bernard Baruch as American member). Manhattan District announces availability of radioactive isotopes for research use.
12. **July 1946.** Joint Army-Navy tests of atomic bombs at Bikini.

...but if Man Masters Atom...

IF MUTUAL DESTRUCTION by the atomic bomb can be avoided, the first century of the atomic age will bring immense advances in scientific knowledge, health and living standards. Already many prospective benefits can be outlined, but those we can neither foresee nor suspect may be even more important.

This prediction is grounded in scientific experience; the most fundamental discoveries have always been the most fruitful. The study of molecules gave us chemistry. Faraday's experiments with electricity and magnetism are the foundation stones of the great electrical industry. Can one expect any less from an understanding of the heart of every atom?

BENEFITS

Atom-splitting benefits clearly visible today fall mainly in three classes: (1) heat and power applications of the uranium piles; (2) general industrial applications of equipment and methods originally developed for the bomb project; (3) chemical, biological and medical uses of the "tagged atoms" (radioactive isotopes) now abundantly available from pile operation.

It is now evident that the energy yield of the U235 in an atomic pile can be multiplied many times by returning to (or leaving in) the pile the plutonium and possibly the U233 produced respectively from the U238 and the thorium in the pile. This is an indirect way to "burn" inexpensive U238 and thorium, and thus greatly extend the supply and reduce the cost of atomic fuels.

POWER APPLICATIONS

Although present piles run at low temperatures, it is certain that temperatures high enough for the efficient operation of steam and gas turbines will be attained. Already an experimental atomic power plant has been ordered. Atomic power for certain remote installations (say, for heating Arctic airports) may not be far off.

In five or ten years uranium piles will be driving a few experimental ships and submarines. In 20 or 30 years uranium may begin to compete widely with coal as a fuel for suitably situated large central heating and power plants. The 50-ton minimum weight of shielding rules out nuclear power for automobiles and small piloted planes.

SPECIAL USES

Some day ultra-high temperatures from splitting atoms will be used for special industrial operations on metals and other materials. Even the dread atomic bomb might easily serve peaceful ends — blasting lakes in deserts, changing the course of rivers, leveling mountains.

INDUSTRIAL BYPRODUCTS

The special industrial equipment and methods developed for the bomb project will find hundreds of important uses — mostly for purposes unrelated to atomic energy. These developments include pumps with neither seals nor leaks, leak detectors of amazing sensitivity, ultratight welding, a portable mass spectograph for quick and automatic gas analysis, new ways of handling corrosive and poisonous materials, new diffusion barriers for the separation of gases and of petroleum products.

TAGGED ATOMS

Yet more important than any of these, in the long run, will be the hundreds of radioactive isotopes now available as by-products of pile operation. Chemically indistinguishable from the ordinary forms of the elements, these isotopes serve as tagged atoms or "spies" if mixed with common stable atoms of the same species. They "fly with the flock," and can later be identified as surely as banded birds. With these amazing tools of research, the course of any element or compound may be traced through the bodies of men, animals and plants. Similarly, tagged atoms may be used in studying the course of many kinds of industrial and chemical operations.

BIOLOGY AND MEDICINE

A suspected hyperthyroid condition can be diagnosed by feeding the patient a minute measured amount of radioactive iodine. The click of a "Geiger" counter placed on the patient's neck will tell (1) what percentage of the swallowed iodine concentrates in the thyroid cells and (2) how rapidly that concentration is accomplished — giving a definite indication of the state of the gland.

In similar fashion the radioactive isotopes of hydrogen, oxygen and carbon will trace out the intricate transformations of carbohydrates and proteins in the human body. Radioactive phosphorus will explore the bones. Radioactive iron will show how and where blood cells are formed. Radioactive sodium will time the circulation of blood.

USES IN INDUSTRY

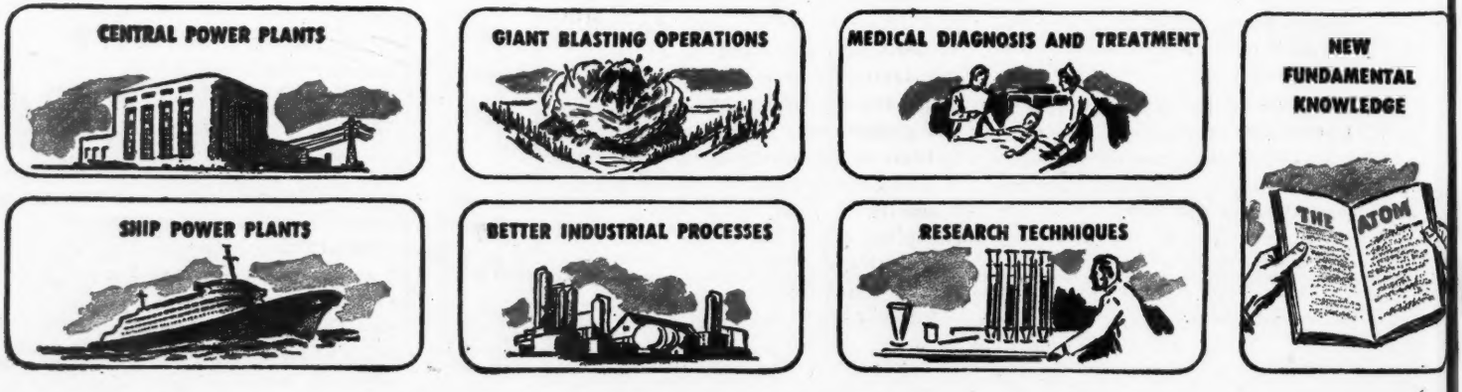
In chemistry the radioactive isotopes will speed the understanding of metallurgical and organic reactions. In industry they will measure flow, detect leaks, and do other useful work.

Meanwhile the uranium piles will be manufacturing certain radioactive isotopes that can serve as cheap but effective substitutes for high-cost medical radium.

KNOWLEDGE COMES FIRST

It is already clear that the chief benefits of atom splitting will come first as new scientific knowledge rather than as new engines and gadgets. But in the long run man's new understanding of the inner atom will enrich the whole range of human activity. This has always been the case with less fundamental discoveries in science. It can hardly be less with this most fundamental discovery.

ATOM SPLITTING WILL SERVE MAN IN:



EDITORIAL

SO . . . DON'T WRITE OFF PISTON ENGINE DEVELOPMENT

A LOT OF CONFUSED THINKING about aircraft power plants has resulted from recent British announcements that "All large airliners to succeed the present interim types will be powered by pure jet or airscrew-turbine units," and that "Large piston engines will soon be a thing of the past."

In evaluating these statements, we should know more about what is meant by *interim* and *soon*.

There is no longer any doubt that jet engines and gas turbines will some day occupy a prime place—probably the most important place—in the aircraft power plant spectrum. But it is exceedingly dangerous to predict just when such units will completely replace large reciprocating engines, or exactly where the transition line will be between reciprocating and turbine types. Any power unit which is capable of developing greater output for a given weight and size is destined for a brilliant future in aviation. But it is being recklessly impulsive to pin all hopes on a development that must go through all of the growing pains of technological progress.

In the field of fast fighting planes, where economy is secondary to performance, the place of the pure jet engine is quite clearly defined. When you attain speeds of 500–600 mph., even existing types of jet plants are most attractive. There still remains the problem of reaching high speeds efficiently, and reciprocating engines with propellers have solved that problem in several recent designs. Turbo-prop combinations may serve this purpose in the future.

In the commercial field, the turbine-propeller combination is highly attractive for large airliners. But there the question of economics rears its ugly head, and the airlines of the world, including the British, are spending many millions of dollars for "interim" equipment powered with large reciprocating engines. The interim period must last until airliners powered by gas turbines are proved more economical to operate than the interim types.

A PART OF THE REASON for the current boom in U. S. domestic air travel is that airline fares are generally lower than first class rail transportation, and airplanes deliver passengers and cargo four or five times as fast as trains. Whether the public will pay more for even greater speed is a question for study. Domestic airline operators on many routes are always torn between the extremes of fewer schedules with larger planes or more frequent service with smaller ships. Some day, passenger load factors will fall off, and sound operation demands planning for that time. The tempo of business and the methods of ground handling of passengers and cargo are not yet adjusted to speeds of even 200 mph.

Transoceanic and intercapital services are in a different position. Here, there is a more immediate place for a relatively limited number of larger and faster aircraft. This field bears some resemblance to that of the ocean luxury liner, where operating economies bow to promotional prestige. Such service could someday afford a proving ground for large, fast airliners powered by gas turbines driving propellers. We must not confuse the vaguely promised British-built turbine-powered transocean airliners having speeds "approaching 600 mph." with the interim equipment of British Overseas Airways—American-built Lockheed Constellations with large reciprocating engines, available now.

Closer perusal of British statements reveals that "There is no military or other source from which we can draw data on the far more complicated turbine-airscrew units." The frankness of this statement by our esteemed contemporary, *Flight*, is both commendable and realistic. And so is the recent British move to temper its policy of nationalization by logical utilization of the brilliant talents of Air Commodore Frank Whittle to direct Britain's all-out effort in the field of jet propulsion research and development. More careful study of the Royal Aeronautical Society's recent symposium on jet propulsion indicates that British scientists are realistic about jet motive power. All of this adds up to the fact that turbine-driven commercial aircraft operation is quite a few years off.

WE CANNOT AFFORD to ignore the pioneering work of the British and Germans in the development of unorthodox power plants. We must continue this important division of aeronautical technology and push research and development even more vigorously than before. But in our proper enthusiasm for these revolutionary prospects we must not yet abandon our efforts to develop more efficient reciprocating types and combinations of both.

At present, the future is wide open. We may find commercial practicality in the compound engine so ardently espoused by Dr. H. R. Ricardo of the RAS. We may find it in some combination of reciprocating engine and turbine especially designed to utilize the now-wasted exhaust energy. Experiments along this line have shown an increased power output of as much as 70% for a given fuel consumption. Or we may discover it in some novel combination of piston and turbine engines. But wherever we find it, we may expect that the new power plant will be a compromise, in mechanical complexity, between existing reciprocating and turbine types.

It is still to early to think of discarding reciprocating engine development, which must continue side-by-side with the work on gas turbine design until the sphere of each type is more clearly defined, and every possible combination is considered and tried in specific aircraft designs. And only by this method will we determine the next stage in power plant progress.

Leslie E. Neville

EDITOR

SOLDIER BEWARE

By **KENNETH R. MacDONALD,** *Manager, Aviation Department, San Francisco Chamber of Commerce*

SO YOU ROLLED UP 1,400 hr. flying B-29s, and now that you're out of uniform you want to get into civilian aviation, with a job as an airline pilot or well-paid executive. Or maybe you helped build one of those American airports now dotting the landscape of the world, and with savings and discharge pay you think you have enough money to start an airport of your own. Or perhaps you ferried paratropers or supplies across Europe or the jungles of the Pacific, hence now you dream of launching your own airline.

Lots of luck to you, soldier, it can be done—but stop, look, and listen before you sink all your cash and energy into aviation.

Men who know what they're talking about make glowing predictions of the future of aviation. These predictions undoubtedly will come true—three, five, or perhaps ten years from now. But what about the present? What are the potentialities and the problems facing veterans who want a job or a business right now?

In your absence at war, aviation has become big business, requiring capital, knowledge of sound business principles, and more than just a fair share of good fortune. But like any business, aviation carries with it risks which can, if they're not foreseen, ruin the most venturesome. The largest number of discharged veterans interested in civilian aviation are those looking for jobs. Let's review briefly some of the troubles ahead for this group.

Competition is the greatest obstacle when a man seeks the precise job of his desires. According to Air Transport Assn. estimates, the war period produced 2,500,000 aviation trained vets; 350,000 military pilots; 150,000 civilian pilots; 2,500,000 aircraft workers; and 300,000 aviation students. Then the war end saw cutbacks which slashed a peak $20,000,000,000 output and a payroll of 2,000,000 workers by more than 95%. The most optimistic current production estimates call for 1946 output of less than $1,000,000,000 in military planes plus about $200,000,000 in civil craft.

A slash of such magnitude can only mean far fewer jobs available in aircraft production plants at a time when many more workers are searching for them.

The veteran seeking an aircraft manufacturing job stands little chance of getting that job, unless he is a highly skilled, highly trained engineer, designer, or craftsman whose abilities fill a specific need. The wise veteran will skip the larger plants and concentrate on the smaller factories now beginning to produce light, personal type airplanes, and on manufacturers whose personnel needs are related to aviation.

He may be able to utilize his skill and knowledge of planes in the repair and maintenance field, for corporation planefleets, or for charter operators, or for a school, public or private, or perhaps even for a commercial airline. There are possibilities in the airline field, which is expanding in preparation for the peacetime boom in air travel. But here, again, the competition is severe, and so the jobs are comparatively few in number.

Read this sound advice about opportunities—and pitfalls—in the aviation industry before you put your money and your time on the line.

In 1941 there were 100,787 certificated pilots in the U. S., of whom 1,587 were airline pilots and 15,429 were commercial pilots. In the same year the major domestic airlines employed 18,984 men and women, of whom only 2,184 were pilots and co-pilots. By 1944, the number of certificated pilots increased to 132,432, with airline pilots increasing to 3,046 and commercial pilots to 22,059. ATA airline personnel by 1944 had jumped to 31,094, but the increase in pilots and co-pilots employed was only 665 over 1941's total. With 3,046 pilots available in '44, the airlines employed only 2,849 to fly 228 planes, 131 fewer than the total in service three years earlier.

Today, the airlines are operating approximately 500 planes daily and have on order more than 500 new transports, delivery of which will not be completed until early 1948.

CAB estimates that one average commercial passenger transport requires a pilot and co-pilot crew of eleven men. With 500 planes now in scheduled airline service, there are thus pilot and co-pilot jobs for only 5,500. Doubling the number of planes available for operation would increase the number of jobs to only 11,000. The odds are against the ex-military pilot finding the job he wants flying an airline plane.

CAB records indicate an airline needs approximately 150 men to keep one average transport in operation. With new, heavier, more complicated planes, that number might be increased to 200. With only 500 planes in operation, however, that's only 100,000 jobs. So it's obvious that, even if the ex-serviceman pilot is willing to accept non-flying airline work, such as ground service, sales, promotion, etc., the competition still is severe and the jobs few. There *are* jobs available, though, for the veteran who uses initiative and imagination and who is willing to start where 95% of present airline executives began their long trek to the top.

One airline in the New York area has increased its personnel by 2,023, of whom 1,608 are servicemen. That's 80% employment of veterans, probably one of the highest percentages in the country. This company, by the way, lost 2,185 employees to military service and to date almost 800 have come back to their old jobs.

Selling tickets isn't as glamorous or well paid a job as piloting, but as airlines expand, the ticket salesmen and mechanics and riggers and hangar and field personnel are going to step up on the airline ladder to better jobs. And the ex-serviceman pilot who isn't afraid of hard work and a gamble on a lesser salary to start, may find opportunities with new feederline operations, charter services, flying schools, and with business concerns.

Many vets have discovered that, much as the airlines and factories want to help, there just aren't enough jobs to go around. So they've turned hopefully to airport employment. Here, too, the jobs are few, as against the competition for them. In 1941, the total number of employees on the 2,369 airports of which CAA had records was less than 10,000, including all types of workers. The number of airports have increased since then to slightly less than 4,000, and the number of jobs also have increased—but not

to the point where airport jobs are available for all who want them.

Of course, job opportunities at airports will be improved as a result of the recent Federal Aid Airport Act which, over a period of years, will increase the total number of airports to about 6,000 and expand about 1,600 existing fields.

Most municipally operated airports hire employees through Civil Service, and with their jobs thus protected, the turnover generally is low. Non-subsidized airports, with few exceptions, are the personal projects of one or two individuals who handle all the work themselves and thus, understandably, have little to offer the job seeker. It is possible to get a field job, however, through persistence and thorough planning. First step is to get a CAA list of fields and then canvass all possibilities. There is no substitute for the experience gained by working for someone else if you aspire to go into business for yourself.

Hundreds of veterans with aviation training, experience, a few thousand dollars, and a craving for independence, however, are leaving the job hunting to others while they set up enterprises of their own. Many believe that all that's necessary is to buy a surplus plane and begin carrying passenger and cargo, or find a large plot of land, erect a sign, and go into the airport business. It's not quite that easy.

The veteran who succeeds, however, will be the one who understands the obstacles he faces and who uses intelligence and planning to avoid every possible pitfall. Even those who fail, if they profit from the knowledge gained, may try again and, on the second attempt, make a go of it. Servicemen will discover that flying a plane of their own for profit is a great deal different from flying for Uncle Sam with the Government footing all the bills.

Here, depending on the type, you initially pay from $1,000 to as high as $60,000 or $100,000 for your craft. Then you must pay for any modification or conversion necessary. You also foot the bills for maintenance, fuel, storage, insurance, and replacement of parts—all of this is your expense, yours alone.

Knowledge Required

Suppose you have a partner or two—other vets who, with yourself, have money enough to buy a couple of surplus planes. You buy them, spend several thousand dollars reconditioning them, and then you're in business to carry cargo or passengers. And your overhead, whether large or small, goes on from that day forward. You're businessmen, but do you know the sound principles required in order to run a successful business? Are you *sure* the sheriff will stay away from your door? Let's go into more detail:

Do you know the legal problems involved in establishing your own business? Are you acquainted with the bookkeeping procedures to enable you to know whether you're losing money? Have you knowledge of how to go out after business and where to go? Do you know salesmanship, and advertising, and finance, and insurance, and the laws which affect you, also the taxes you may have to pay?

Okay, so you can learn all that. True, you can. But your chances of success are much better if you learn before going in business—before overhead starts.

Here are some of the troubles you may face and some suggestions as to how to meet those troubles:

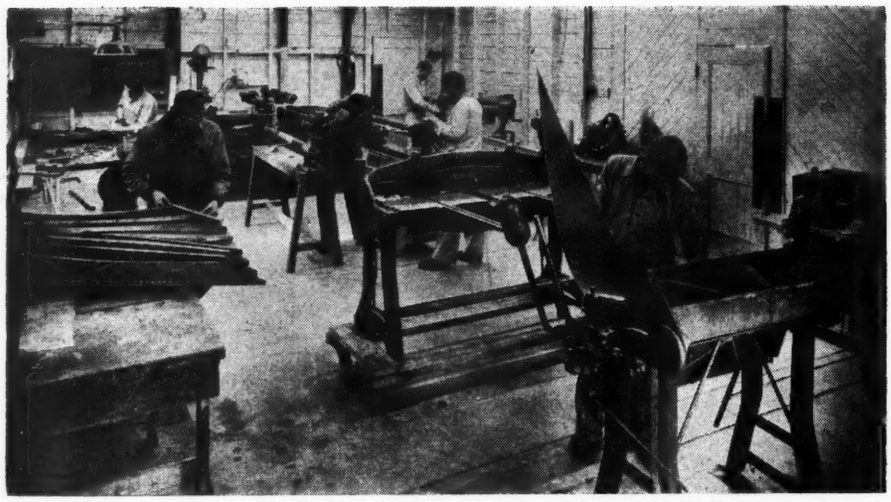
The cost of your plane purchase will be high in proportion to the amount of capital the average veteran possesses or can raise. Your repair, maintenance, and replacement costs will continue whether business comes in or not. You can help to meet the cost problem by a pooling of resources, or cooperative financing, and by judicious use of your credit rating and local banking facilities. Perhaps some friendly business man in your community or your own acquaintances will help finance you. Any of the larger banking organizations will finance your plane purchase at fairly reasonable interest rates. And by utilizing the GI loan rights you can obtain additional funds to help cover operating costs.

Regardless of how you raise your capital, don't get involved financially beyond your point of recovery, and don't get so many backers that your net profit dwindles away to zero.

If you want to fly scheduled service between fixed points, you'll have to apply to the CAB for certificates of convenience and necessity—and remember, the Board is now swamped with more than 500 new route applications. If you must fly scheduled service, be prepared to prove your case in a thoroughly documented manner, also to wait anywhere from one to two years and spend several thousand dollars before your planes leave the ground. Should you have that much money and that much time, you will protect your investment and save yourself headaches by hiring an attorney experienced in CAB cases.

If you want to get into non-scheduled service, carrying cargo or passengers on a contract basis, first explore the legal

Airport operators no longer carry business facts and figures in their heads. Sound methods of accounting, of costs, and of stock control, as well as legal, insurance, and finance matters, are handled as they are in any other conventional business venture.



Metal working is an important element of aircraft maintenance. Operators are increasing their investments in up-to-date tooling as a means of reducing costs in this type of work.

requirements of the state in which you plan to operate. Be certain you have enough capital to stay afloat a reasonable period of time without any business whatsoever. Then survey carefully the actual need for the type of service you plan to offer. If possible develop your contracts or sources of contracts before you begin operation. Then be prepared to face unlimited competition from both the commercial airlines (which are getting more and more deeply into air freight) and from other veterans who have the same idea as you.

If you plan on carrying cargo, you will have to combine the best talents of a salesman, a super detective, a financier, and a pioneer. You will have to use imagination to ferret out sources of payloads. You'll have to sell the idea of shipping by air and by your specific aircraft.

Every veteran interested in the business points to the "Flying Tiger Line" as an example of what can be done. With their National Skyways Freight Corp. the Tigers set an outstanding example of veteran initiative. But they were hit by, and are still being hit by, exactly the same problems every other hopeful charter operator faces. Perhaps their greatest problem has been that of getting return payloads. By hard work, they whipped the problem after some eight months, getting their name before the potential customers. They were constantly "digging" for business.

You can do the same with hard work. You probably will discover, however, that ample capital and offices and salesmen in nearly every important city are necessary to guarantee that a plane will not fly back to its base empty of payload.

Another major hazard for the one- or two-plane operation is the constant possibility of a crash. Sure, you can carry insurance. But even with insurance one bad crash may put you out of business. If you're carrying passengers, this crash hazard is even greater as a potential "knock-out" punch to your youthful business.

Commercial airlines have helped to create a demand for air travel, but they have also set such high standards of comfort, speed, and economy that you will have difficulty competing with them. Your customers also will demand comfort. They'll demand service, too—perhaps not a hostess, but something nearly equivalent. They'll demand speed and rates comparable to the speed and rates of commercial airlines.

Unless you can offer all this, cover your costs, repay what you borrowed, and make an adequate profit on your investment, you may be wiser to save your money and wait for a more auspicious time.

There's something about an airport that is luring a large percentage of veterans into talking business with real estate agents. Perhaps it's the fact that, on the surface (or from the air), it appears so easy to run a small Class One or Class Two airport and make seads of money. Soldier, unless you already know all the ins and outs, go and talk to someone who has been in the small airport business before you invest your money in that big vacant lot outside town. Despite what you'll learn about problems, you're right in believing that the greatest present opportunity rests in the development of small airports for private plane owners.

Without adequate airports there can be no private flying of the magnitude visioned by Assistant Secretary of Commerce William A. M. Burden and others who foresee, given optimum factors, at least 500,000 personal plane purchases by 1956. The number of potential personal plane owners *is* high. But the planes won't be purchased unless there are airports from which they can fly. That's the basic reason why your future as a small airport operator is bright. Despite the future potentialities, however, there are definite hazards and problems you should know about and undrstand before you make the down payment on land. And there's no future at all for you if the kind of airport you want is to be the old-fashioned cow pasture type. The airport also has grown to be a solid business proposition, and to succeed it must be operated as a solid business.

It's obvious that the first problem is finding a suitable location. Size of your airport will depend both on location and on your pocketbook. An airport 50 mi. from town will probably be deserted nine-tenths of the time. And the closer you get to town, the more congested the area becomes and the more difficult to find adequate space. Also, climate and weather conditions should be studied to determine how many days you can operate each year. What's more, there's no point in starting an airport just across the road from one already in operation, even though the land may be available. The end result threatens to be two failures of private enterprise.

Big city airports are over-crowded and offer little room for the private flyer, whom you might be able to serve by locating near the city. Land costs are higher in and near cities. So are construction and labor costs. You probably would get more airport for your money near the smaller cities. Once you have solved the tough problem of location you still may face local resentment against flying and against airports. You may have to wrestle with local regulations, such as building codes, license fees, ordinances restricting your operations or permitting construction near your field which might ruin your business. There may be county and state restrictions as well. and you may discover, after having decided on the "ideal" location, that you simply can't build there. Avoid these pitfalls by working closely with the local city administration, the city or county planning commissions, and the local chamber of commerce.

With just ordinary capital you probably will be restricted to starting a Class One airport, and for that you will need at least one, and preferably two, runways from 1,800 to 2,700 ft. in length. Do you have enough engineering background, or is it available to you, to assure that your airport design is right and that your runways are laid out properly? Are you willing to do all the back-breaking work of putting in runways yourself, or do you have enough money to pay for the job, or enough friends

with enough know-how to help you?

Before you start, call on the CAA for assistance. In particular, ask for a new 26-page CAA pamphlet titled, *Employment Outlook in Civil Aviation.* Among other things, it contains information on how to start and operate a small airport. You can get a copy for 10c by writing to the Superintendent of Documents, Government Printing Office, Washington.

You will have to buy or build hangars for the planes you intend to serve. Do you know the right kind of hangars for the planes in use in your area or those which may land at your field? You will need service facilities, fuel storage tanks, some kind of food service. If your airport is any distance from town you will have to be able to furnish land transportation. For this you may be able to work out an arrangement with a local taxicab company. And you should check with the local office of the large oil companies. Sometimes they can help, for the privilege of a local gas and oil concession.

Construction costs involved in building a Class Two airport would be slightly higher than those for a Class One field, varying, of course, with location. A 3,000-ft. runway, utilizing 160 acres of land, would probably cost you approximately $80,000, depending, of course, on the local land values. Grading would add $10,000 to this, and an additional $6,000 or $7,000 would be neded for landing strips 3,000 by 150 ft. Another $15,000 would be necessary for fencing, wind cones, and other items. The total cost would approximate $100,000 to $125,000. You'd then have an airport which the CAA estimates could safely accommodate a traffic load of 100 planes a day. These estimates do not include such items as hangars, servicing equipment, restaurants, or restroom facilities, or the other services usually demanded.

There are numerous men in the business who can and will be glad to tell you in detail how much it costs to build and operate a topflight airport. Harry White, president of Palo Alto Airport, and Marve Whiteman, who built Whiteman Air Park, near Los Angeles, have spent many thousands of dollars, and their fields are not yet completed to their satisfaction.

An airport with one all-steel hangar for planes and engine repair, an administration building with lounge, runways up to 3,000 ft., adequate paved landing and taxi areas and tie-down space, and individual hangars for storage purposes—gives you some idea of an A-1 project catering to personal plane operators. And costs involved run from $200,000 to $250,000. If you haven't that much money, why not try an airpark or an air strip? Have a single runway, fuel facilities, and an automobile for transportation into town. Such a layout would be comparable to the corner gas station. Later, with hard work and perseverance, it could be built into the type of airport you dream of.

Competition in the operation of airports is severe and may become even more severe, not from private enterprise, but from municipal, county, state, and federal subsidy. The Federal Government, through the CAA, asserts that airport development is fundamentally a responsibility of government. In *Civil Aviation and the National Economy,* issued by the CAA, appears this statement: "The historic American pattern in transportation has been for the government to provide the basic facilities over which our vehicles move, with private enterprise developing and operating the vehicles themselves."

Flying School Potentials

There remains one other phase of aviation for the veteran—that of running a flying school, or a combined flying school and aircraft and engine repair service. This type of business may also be combined with airport operation.

The operator of a flying school must, obviously, have the tools of his trade—an airplane or airplanes, a good airport from which to fly his planes, and the ability to instruct or the money with which to hire instructors. Most veterans interested in this phase of aviation have just about enough money to buy a couple of planes, keep them in condition, fuel them, and pay airport rental fees. That means owner-operation and again a situation where the owner-operator must be a topnotch licensed instructor, crack salesman, expert publicity man, and amateur psychologist, as well as bookkeeper, financier, and businessman.

Original costs, with veterans' priorities and careful searching, should not be prohibitively high. It may be possible to buy and recondition a surplus plane, suitable for training purposes, for from $2,000 to $3,500, plus $500 or $1,000 for spare parts. But the operating and maintenance cost of war surplus planes can easily be higher than that of some of the new planes now offered for sale. Use of surplus equipment, therefore, can be false economy.

Additional continuing costs will include airport rental fees, fuel bills, insurance, advertising, salary for instructors (unless you handle the instruction yourself), repair and replacement costs, and the establishment of a reserve fund for emergencies.

It has been estimated by men in the business of flight training that in order to net $5,000 a year you must have a gross income of from $30,000 to $35,000, and that to achieve such a gross income the investment must be from $15,000 to $20,000.

The veteran who wants to launch a flying school faces almost exactly the same problems as those faced by the operator of the small airport. There's the problem of location, of local restrictions, of taxes and regulations, high operational expenses, equipment maintenance, and competition from other flying schools in the area.

You have, in addition, the weather hazard, which can keep your training planes on the ground and your students inactive. Your only chance to utilize this lost flying time profitably is to give ground instruction, which may increase your operating costs. One-plane operation may permit you to fly as many as 100 hr. a month, with doubling of the hours if you have two planes. Your problem then will be to get and hold a number of students sufficient to keep your planes in the air enough hours to return your costs and a profit.

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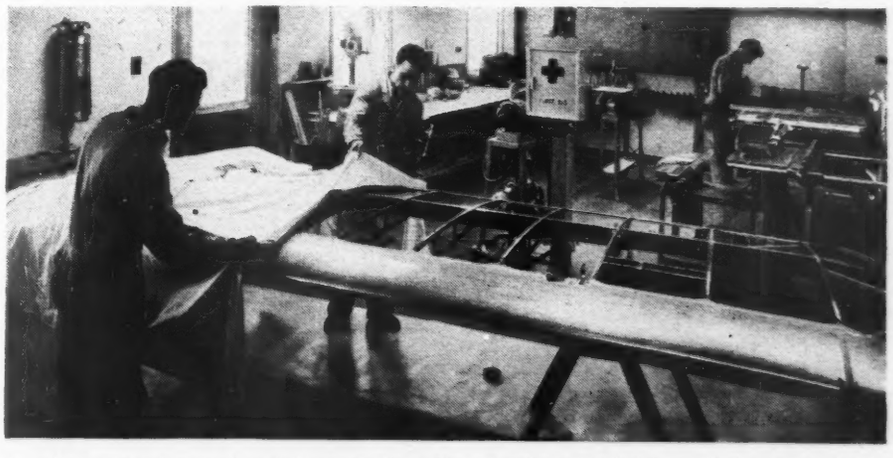


In spite of trend toward metal construction, there is plenty of fabric work for repair-station operators. A high degree of skill is required, and equipment should meet high standards, with dope rooms well ventilated and protected against fire hazards.

WILL GLIDERS CLOSE SOUTH AMERICA'S TRANSPORT GAP?

By **GEORGE M. GALSTER,** *Latin American Analyst*

Recently introduced south of the border, AAA's glider-pickup techniques—dramatically proven in war operations—may presage a literal pickup in Latin America's air cargo business. In his discussion, the author contends that "sky trailers" can go far in solving this vast area's transport problems by effecting greater aircraft utilization and by bridging the lack of airports.

WHEN A TOWED GLIDER hauling a load of Philco radios recently made a successful flight from Philadelphia to Havana and San Juan, it dramatically keynoted the possibilities of similar services now being developed by our Latin American neighbors.

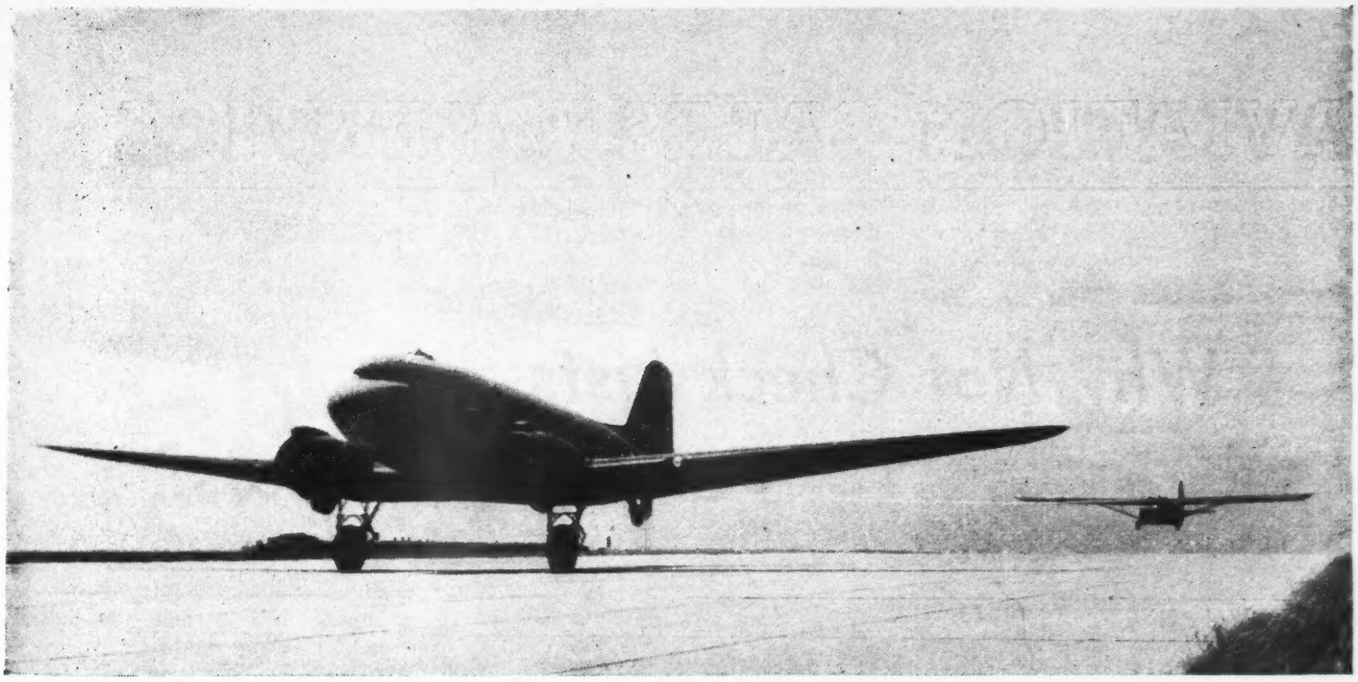
All American Aviation, pioneer of the air pickup system and maker of the equipment the Army used to snatch up heavily laden invasion gliders, prepared the way for glider use in South America by establishing a Brazilian subsidiary in June, 1945. This organization—Aparelhos Aeronauticos All American, S.A.—is not operating a line itself, but instead is installing pickup equipment and is training personnel for various Brazilian airlines. One of these, Servicios Aereos Cruzeiro do Sul, actually began cargo pickup operations early last fall with a converted Junkers JU-52. Officials have announced that the picking up of gliders, which will probably carry passengers, will be undertaken as soon as facilities can be set up.

Service similar to one inaugurated by Winged Cargo, Inc., points up lucrative possibilities that might be developed in supplying otherwise inaccessible markets within South America through medium of cargo gliders. Here, Mayor Samuel of Philadelphia (left), congratulates Philco Vice-President T. A. Kennally on first air shipment of radios to Cuba and Puerto Rico. Standing alongside is Dempster McIntosh, president of Philco International Corp., and at right is Winged Cargo's president, Col. Fred Dollenberg.

All American is planning similar service companies in other South American countries. In Colombia three Avro Ansons of Lansa, Ltda., are being modified for pickup service. Maurico Obregon, who originally discussed the project with All American officials, declared that his company was definitely interested in the cargo and passenger potentialities throughout this area.

As far as the actual supply of gliders is concerned, reports from both Canadian and American surplus property commissions indicate that war stocks can supply this need for some time to come. And Laister-Kauffmann meantime has gone ahead with a vigorous sales campaign for an improved model of its CG-10A Trojan Horse glider. The company's foreign sales department is conducting a series of pickup and landing exhibitions in Latin America to interest mining companies and other industrial firms in the use of gliders.

It is not surprising that the first commercial air pickup service outside the United States, should be operated in Brazil, since this South American country already has one of the finest of airway systems. Some indication of the interest with which Brazilians are observing pickup operations is evidenced in the list of directors for All American's subsidiary. Included are Dr. J. B. Ribeiro Dantas, pres. of Cruzeiro do Sul; Dr. Carlos P. Sampaio, pres. of Panair do Brasil; and Rubem Barta, pres. of VARIG. The Central Brazil Foundation, a government agency charged with the settlement and exploitation of the Brazilian Northwest, is also critically appraising these experiments, foreseeing a possible tool for its program.



Activities currently underway in Latin America may make scenes such as above a familiar sight south of our border. All American Aviation, pickup pioneer, is busily engaged in aiding establishment of commercial glider cargo services throughout South America.

But why are gliders so admirably suited to Latin America? Answer: Because many analysts have pointed out that overall efficiency of most transport planes can be improved when used in conjunction with properly designed gliders. And glider service can bring air transportation to any area not possessing well-developed ground facilities. But let us consider the matter in light of some of the basic differences which exist between the United States air transport system and that of Latin America: The biggest factor is, of course, that the South American republics never developed extensive highway or railway networks, such as are common in the United States and, consequently, for many of their people there were no intermediate steps from the oxcart to the airplane.

Where other forms of transportation require days or even weeks, it is of little concern whether an airplane is the latest or most comfortable type, or can arrive at a given destination in two hours instead of three. Except for more competitive trunk lines, most Latin American air routes operate on a simple ton-miles/dollar relationship in which factors of time and comfort are more or less neglected.

Another important factor is that Latin American aviation today is in a state of flux similar to the condition which existed in the U. S. in 1930—new companies are being formed, others are being reorganized, consolidations are developing,—a situation which makes favorable new ideas and techniques. The people have a vigorous pioneer attitude toward the future that is reflected in the frequent use of two key terms—"fomento" (development) and "comunicacion" (communication). Popular acceptance of glider service seems to be assured.

Latin American air transport operations are characterized by a generally low profit margin traceable to high operating and depreciation expenses, low value cargo, poor utilization of equipment, and the necessity for companies to provide their own ground facilities. Moreover, Latin American governments have not fully accepted responsibility for providing essential radio and meteorological aids for commercial aviation. Consequently this load, as well as a large portion of the airport development costs, has been borne by the companies themselves. To offset this situation, it has been estimated that gliders can more than double the load capacity of a given system for only a 50% increase in capital investment.

In addition, substantial savings can be realized in fuel consumption per ton-mile, in maintenance and maintenance equipment costs, in airport installations, and in the number of necessary ground personnel. This last point is an important item, since Latin American operators have been constantly hampered by a shortage of overhaul facilities and trained technicians. It is pointed out that military gliders have proved to be surprisingly durable pieces of equipment. The small amount of maintenance work they do require can be taken care of in the field by relatively inexperienced mechanics.

The aircraft utilization rate has consistently remained at about one-third that of the U. S. domestic system. While this average exists chiefly because of a lack of night flying, night glider operations will pose no additional problems, for lighting facilities are now gradually being installed. Moreover, a carefully integrated glider pickup system may greatly decrease flight time lost through loading and unloading.

For instance, several years ago, when a valuable gold mine was being opened up in Peru, two conventional transports were used to haul all the mining machinery. Flying time from the operations base was but 9 min., yet, because of time lost in loading and unloading, each plane averaged less than three round trips per day. A similar job in the near future could conceivably be handled by a single non-load-carrying tug plane and three or four gliders—at a fraction of the time and cost.

With all these considerations, the possibility that a reasonable volume of traffic can be built up in an area, without first spending large sums for ground facilities or expensive equipment, may well prove to be the best selling point for glider use in South America. During 1942-1943, numerous war-valuable mining and rubber-tapping areas, accessible only by air, were opened up on what was then a non-economical basis. Now many of these settlements, still depending solely on air transportation, are rapidly developing into centers of diversified industry and agriculture.

This has been especially true in the more remote sections of eastern Nicaragua, in the mountainous regions of Peru and Bolivia, and in the vast Amazon Basin.

Plainly, Latin America is entering a new era. The airplane that has overcome natural barriers in the past now has a junior partner in the glider—which can extend the air network to remote villages.

Why Not Check Lists For Private Pilots?

By WILLIS L. NYE

Even the smallest planes require one or more operations in each of six phases for a successful flight . . . Here is a means of increasing long-range sales by promoting safety from the very beginning.

DURING THE RECENT WAR, when thousands of young men had to be taught to fly in a very limited time, there were a disheartening number of takeoff crashes, many of which could be attributed only to inexperience and poor piloting technique.

Undoubtedly many of these crashes were caused by lack of flight time and experience with the specific type of plane involved, but it is also probable that a considerable number were caused by improper operation of some small control.

Now, with a rapid increase in personal flying, the rate of civilian accidents is beginning to rise alarmingly, so fast that it may well have a detrimental effect on long-range sale—and service—of personal aircraft.

This article, then, presents one means of checking this accident increase, a simple means which can be affected by the aircraft manufacturer, the distributor, or the individual dealer.

AAF Safety Research

As is well known, the takeoff is a crucial part of every airplane flight, and if it is made safely, at least 20% of the causes of accidents are precluded. When research was made into the causes of AAF crashes, the Office of Flying Safety recommended that a check list, applicable to the specific type of plane involved, was to be supplied to each pilot prior to takeoff.

Use of these specialized check lists was made mandatory. It required that the pilot—and if he had one, the co-pilot—review the list prior to and during all flight operations, relative to the basic operational sequences of piloting that particular type of plane.

This use of the check list did not apply only to combat or transport aircraft; it was, at least in the AAF, applied to primary training classes, on the sound theory that if a man were to use check lists, he might as well start out with them so that eventually their use would become second nature.

But, it may well be asked, what has this discussion of military pilot check lists to do with operation of civil aircraft? Any review of accident statistics will show a relatively large proportion of mishaps occur during takeoff and landing. For example, on those civil aircraft which have retractable landing gear, many unintentional wheel-up landings have been made—and the airplane damaged.

A check list no doubt would have eliminated a reasonable number of these accidents—and anything that can reasonably add to accident prevention is a worthy contribution to the expansion of personal flying. Such a guide would also go far to inspire more confidence on the part of novices.

Any study of the basic fundamentals of piloting operations will show check list actions to be applicable to all power driven heavier-than-air craft—

1. Prior to starting engine or engines,
2. During engine starting and warm-up,
3. Prior to takeoff.
4. During takeoff and the initial phases of cruising flight.
5. Prior to landing, and
6. After landing.

The six fundamentals will apply—regardless of whether a single-engine lightplane or a multi-engine transport is to be flown. Obviously, the number of operations or control actions will vary with the size of the plane, but even the operation of the smallest lightplane will require coordinated action by the pilot during each phase.

Thus, an enumeration of specific flight action may seem superfluous to the experienced pilot on some certain type of plane, but it seems patent that a review of such a list has more-than-average merit for every student, indeed for everyone stepping into a strange craft.

Let us, for instance, review the pilot's operations for a conventional single-engine lightplane. For the six basic fundamentals, we find these:

Before Starting Engine

1. Unlock controls (if locked), operate controls, and make rapid visual check for proper operation.
2. Check enclosure to make sure it is free of dirt to insure maximum visibility.
3. Set trim tabs for takeoff.
4. Check brakes for proper operation.
5. Check quantity of fuel and oil.
6. Adjust seat for comfort and rudder pedals for distance; also check security of safety belts.
7. If a parachute is worn, check pack for proper adjustment.

Starting Engine and During Warmup

1. Open fuel shut-off valve.
2. Set fuel mixture control (if provided) in Off position.
3. Open throttle to idling position.
4. Set carburetor heat control to Cold, unless icing is evident.
5. Prime engine, if necessary.
6. Set ignition switch in On position.
7. Set engine starter energizer in On

position for 30 sec., then perform meshing operation while holding energizer switch in On position.

Before Takeoff

1. Set altimeter and correct setting if necessary.
2. Check instruments for proper indication after engine is running.
3. Set primer in Off position.
4. Set flaps (if provided) in proper position.
5. Warm engine to proper operating temperature.

Takeoff and During Flight

1. Open throttle for maximum power during takeoff.
2. Set throttle for proper cruising operation once sufficient altitude is attained.
3. Adjust trim tabs for proper balance.

Before Landing

1. Check altimeter indication.
2. Set trim tabs as required.
3. Set flaps as required for approach.
4. Set throttle as required.

After Landing

1. Set flaps in Up position.
2. Stop engine by closure of fuel line shut-off valve.
3. Set ignition switch in Off position.
4. Set all switches and controls in Off position and lock.

Now this list of normal flight operations for a small personal plane may appear lengthy—and probably it is for some specific planes—but there seems no reason why it should be thought excessively cautious for a pilot to check such a list. Many sensible pilots think not, agreeing that encouragement should be given to the use of a standardized list for each type of plane.

It may well be true that most instructors drill the actions into their students so that they may become routine, but wide experience has shown that one or more operations may easily be overlooked.

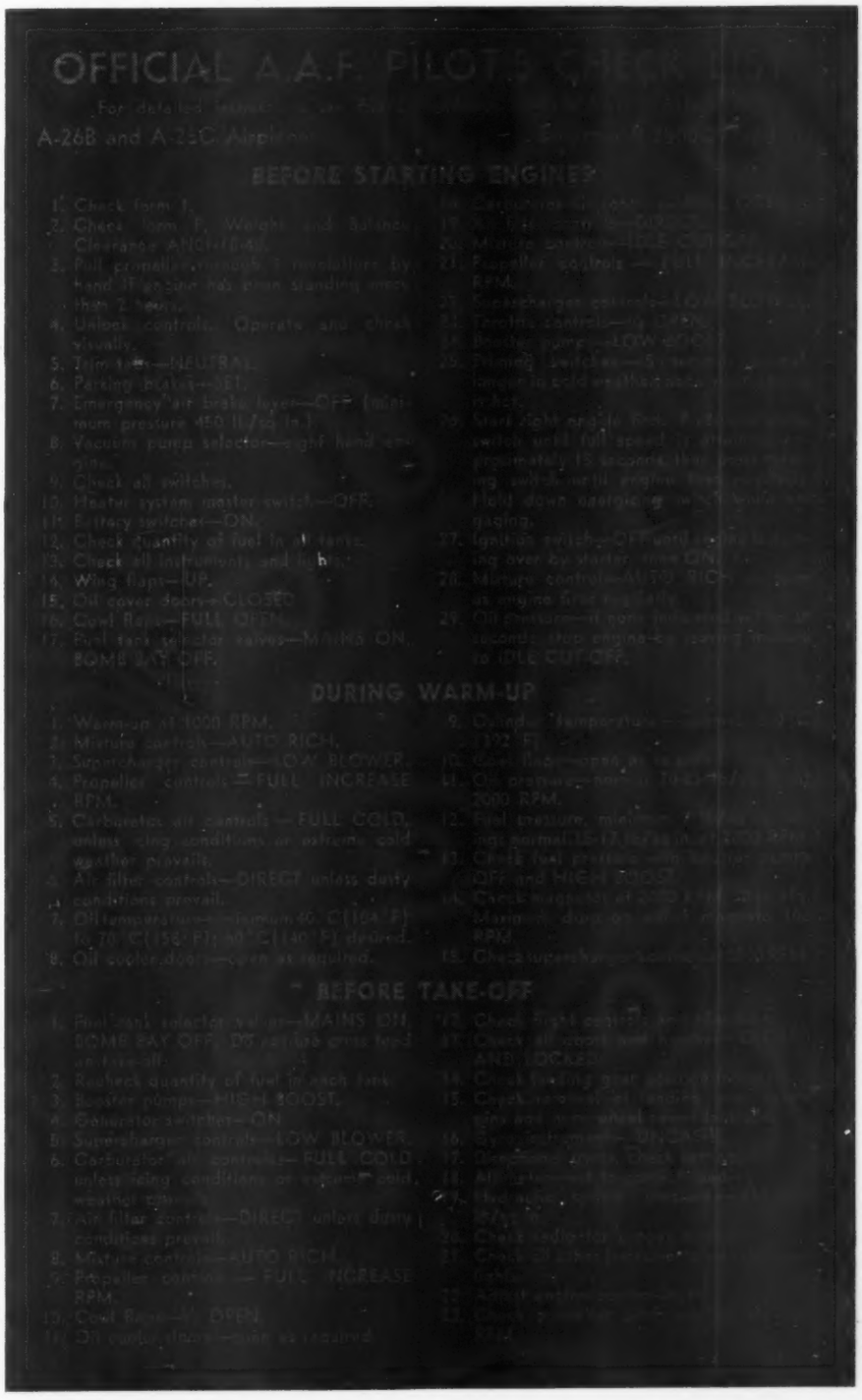
If such check lists were to be required, it is apparent that enforcement for their supply should come from CAA. Naturally, the harassed manufacturer and his distributors and dealers may say that any more regulatory action is undesirable. But lethal accidents are also undesirable.

It is, therefore, suggested that the pilot's check list be prepared by the manufacturer and supplied the CAA for issuance with the license for each plane, the list to be mounted in the cockpit or, at least, placed in the map case or glove compartment. During the war, the AAF supplied luminous cards with plastic holders and, until these cards were aboard the aircraft, there was no acceptance by the AAF.

If official issuance of such lists—perhaps considerably shorter than the one presented above—were the concern of the CAA, there is little doubt that additional flying safety would be gained. At the very least there would be no rational excuse for anyone piloting an airplane not having official information for basic operations.

Enforcement of the use of check lists might be on a voluntary basis at civil airports, with the lists supplied either by the manufacturer or his sales outlets. Use of the lists could supplement flight and operations handbooks now compiled by manufacturers and constitute ready aid for the pilot at any time.

This much seems clear: If pilot check lists functioned well for the military services, there is no apparent reason why equally good results should not be possible for civilian pilots.



Pilot check lists, such as this for the A-26, were found to keep more military pilots alive longer, with result that they were adopted from beginning of AAF training. Author Nye suggests that similar—though shorter—pilot check lists can increase sales through promoting safer flying.

Broken line area indicates buildings leased by Hawthorne from WAC and remodeled. (A) is Hawthorne Airmotive's overhaul shop; (B) is main office; (C) contains snack bar, storage, print shop, and dark room; and (D) is Hawthorne Aero Supply's main warehouse, office, and store.

War-Baby Flight School Becomes Focal Servicing Base

An AAF flight cadet school, basing 130 primary trainers, shut down after hostilities and seemed destined to become a "ghost airport". But then Operator Beverly Howard took a chance—and a lease—on the field's facilities and, utilizing wartime-learned maintenance lessons, is now enjoying an expanding business, using the field as a central base for his own operations and for servicing transients with supplies and repairs.

A BELIEF that the deluxe facilities of a former bustling AAF war training school for flight cadets could be operated profitably as a private enterprise serving flying activities in the Southeast, led Beverly Howard to lease part of Hawthorne Field from War Assets Corp.—to use as headquarters for his system of six airport bases in the Carolinas and Georgia and a charter and sightseeing operation at Washington National Airport.

Built from scratch in 1941 on 525 acres south of Orangeburg, S. C., the field shut down last October after having turned out 5,924 cadets with a total of 329,332 training hours. It was the last such facility to be closed. In addition to the AAF program, hundreds of French cadets received their wings at this field.

Flight line facilities, which once handled 130 AAF primary trainers, lend themselves admirably to this new central base of operations. Under the terms of the lease, the company is to maintain the barracks, flight academic facilities, mess hall, and other buildings. Today, almost a year after military operations ceased, the buildings and grounds look virtually as well kept as during the busy days of cadet training.

Specific facilities used by Hawthorne are two large steel hangars with adjoining lean-tos, the three story operations building, and what was formerly the pilots' building.

These structures are located south of the paved oval road running around the main building area, and are adjacent to the 600 ft. parking ramp and to the field itself, where the longest runway (northeast-southwest), is 5,000 ft. long. Although transient aircraft normally stop at Hawthorne Flying Service on Orangeburg's municipal field closer to town, the ramp at Hawthorne Field is dotted at all times with aircraft of visitors stopping for maintenance service, supplies, or business with the main office.

Focal point of the entire system is the attractive white shingled brick building formerly used for instructors' lockers and squadron rooms. With lockers removed, the central room, measuring 30 ft. by 53 ft., is used to house stenographers and bookkeeping facilities. The four former squadron rooms are private offices for Beverly Howard; W. R. Baldwin, general manager; R. O. Person, comptroller; and W. Ted Gannaway, director of sales.

Printing Shop Is a Feature

A central switchboard connects all desks and hangar offices. In the former operations building, a small snack bar is being built on the first floor. And on the second floor is a facility unique at any airport—a complete printing shop, for making forms, posters, and other advertising matter, as well as a photographic dark room.

In the west hangar is located Hawthorne Aero Supply. The hangar measures 140 ft. by 120 ft., including lean-tos on either side. In the 120 by 20 ft. lean-to on the field-side of the hangar are the main stock bins and racks for a multitude of airplane and engine parts. In the corner room, which once was the cadets war room, a modern parts store is being built adjacent to the offices of John Hammett, Aero Supply manager. Purchasers flying in to pick up parts can park within 25 ft. of the store.

Additional space for parts racks and shelves has been provided in the main section of the hangar. This section has been partitioned off, and it provides ample space for stocking complete wings and fuselages. Balance of the hangar space is used for storage of new and used aircraft and company planes. The north lean-to contains a fully-equipped parachute rigging room, including a drying loft, packing table, and sewing machines. Other space is available for storage.

Master Overhaul Base

Biggest development has been the establishment of complete shop and overhaul facilities in the east hangar, which had been used for maintenance of the trainers formerly based at the field. An all-steel structure measuring 140 ft. by 180 ft., the hangar has an insulated ceiling and is heated by large blowers.

The master overhaul base operates under the name of Hawthorne Airmotive and, when final installation of new equipment is completed, the shop will be one of the most complete in the South. It is under the direction of Sam R. Monschke, formerly an airline maintenance man and CAA maintenance supervisor in CPTP. During the war he had been in charge of maintenance at the field. Many of the lessons learned in production-line care for military aircraft are being applied. During the war, 6,532 25-hr. checks were run, and 3,672 100-hr. checks were made on Boeing PT-13s and PT-17s.

North lean-to contains main offices, wash room, accessory room, stock room, and engine overhaul room. The south lean-to contains a sheet metal shop, welding shop, woodworking room, radio room, and a dope room. The central area of the hangar is devoted to storage of aircraft on which work is being done. A clear space of 100 ft. by 180 ft. allows two lines of normal-sized aircraft on either side, leaving a clear central aisle large enough to move ships in and out without disturbing work being done on individual craft. This feature alone makes for considerably more efficient production, since time isn't lost in picking up tools and moving one ship to let another out.

Work Specialized

Specialization of various productive departments—special shops for engines, accessories, woodworking, etc.—is also followed through as regards personnel. For instance, in the engine overhaul shop, one man works on cylinders, another on disassembly; one on cleaning, another on inspection. At any one time, six or seven men will be working on a single engine, thus reducing the amount of time the engine is in the shop and making each operation more efficient. This specialization applies to woodworking, doping, radio work, welding, etc. While realization of the specialization goal is not 100% achieved at present, Monschke hopes soon to be able to give a lightplane engine a complete major overhaul "between Monday morning and Tuesday afternoon."

A specified crew is detailed to do special work on transient aircraft or planes coming to Orangeburg for minor repairs on the line. This follows specifically the procedure used during the war, when special line service crews were available for repairing wing tips and making minor adjustments without interfering with the work of regular production line maintenance men.

An example of how specialized repair

A section of company's dope and fabric department. Shelves in back- ground of this former cadet ready-room once held parachutes.

operations can return a damaged airplane to service quickly is the case of a Piper Cub which landed on its back 100 mi. from Orangeburg on a Monday. The plane was flying again on Friday after major repairs which involved splicing a spar, replacing leading edge ribs, engine cowling, windshield, center section, propeller, lift struts, repairing the rudder, and recovering half of one wing.

A top overhaul on a light engine is now done in one day, as are also 100-hr. inspections. A complete recover and overhaul job on a lightplane and engine now requires two to three weeks.

Many of the tools and machines used have been acquired from Army surplus or were already in use at the field during the war. In the accessory room, for instance, where carburetors, magnetos, starters and spark plugs are handled, are complete generator test stand, carburetor and magneto test benches, and a special cleaning vat. A replacement service is planned soon so that plane owners can swap faulty starters or other accessories for rebuilt ones and thus receive much speedier service.

Unique convenience of Aero Supply's complete stock of aircraft and engine parts and supplies on the same field reduces the need for stocking a large number of supplies in Airmotive's hangar. However, the stock room is still sizable, with fast-moving parts, such as nuts and bolts, fabric, dope, and other materials, kept there for immediate on-the-spot availability. Inventory is kept up to date by means of a complete Cardex file system.

Engine Overhaul

An engine overhaul room occupies nearly half the north lean-to. Like all other work rooms, walls are painted white from shoulder height up to the ceiling for maximum light and employee comfort, and are gray down to the floor for cleanliness. Engines due for overhaul are brought into the shop on mobile engine stands and then disassembled. Parts for each engine are kept together during the entire overhaul process through use of individual, wheeled, multiple-shelf tables. Parts are first thoroughly processed in vats of cleaning fluid and then put through various stages of treatment and inspection before reassembly.

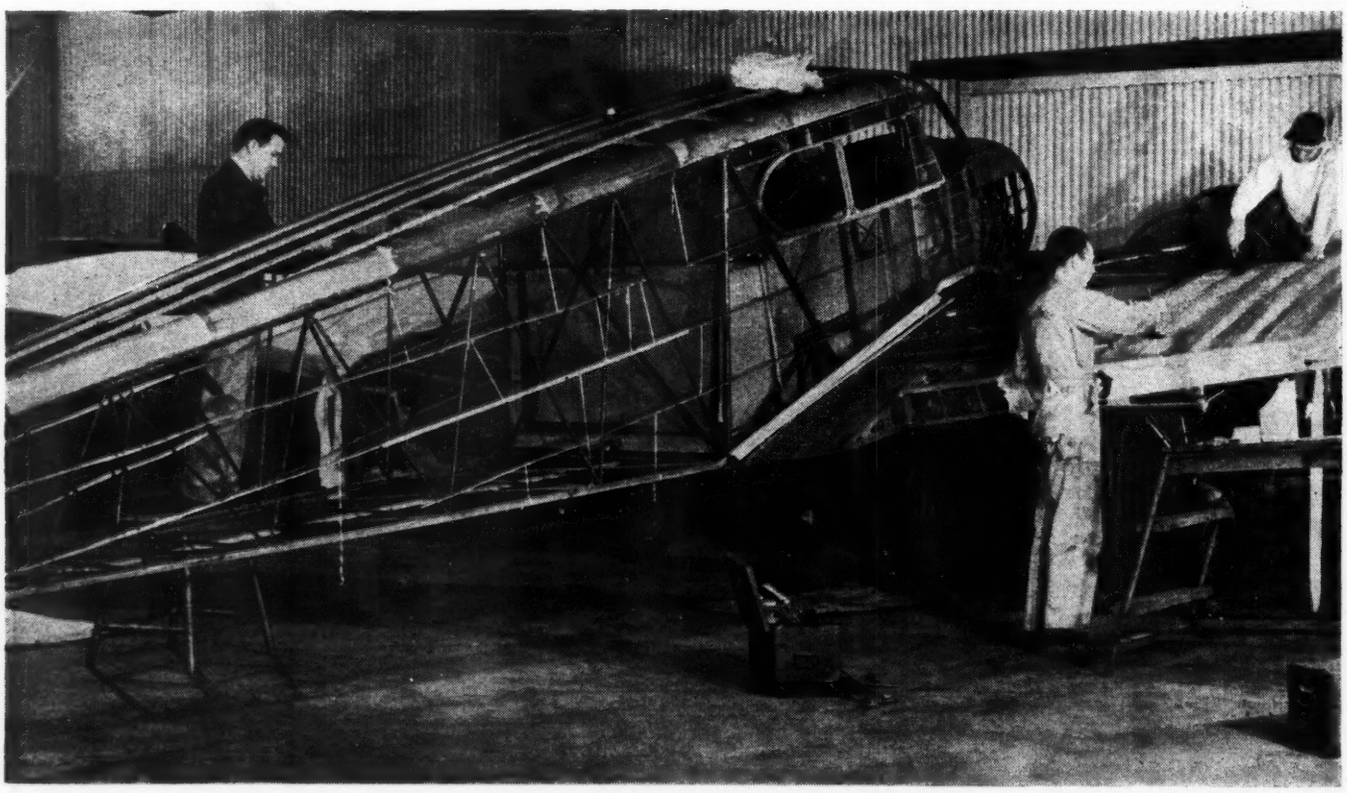
Equipment includes a Magnaflux, Heald cylinder grinder, a specially designed and built cylinder honing machine developed by Hawthorne, and other necessary equipment. In one corner of the engine room is a sand-blasting booth for cleaning engines and for preparation of parts to be metallized.

Across the hangar, the sheet metal, woodworking, and welding departments contain the normal amount of equipment needed for aircraft work. The dope room is equipped with latest safety lighting and exhaust systems. Dope and paint is dispensed from drums stored in a room located off the dope room.

A major alteration in the south lean-to has been construction of a completely shielded radio shop. As distributors for Bendix radio and designated as a master service station, Hawthorne made this installation to handle virtually any type of radio repair. Walls, ceiling, and floors are shielded from outside electrical interference by two layers of copper screen wire 4 in. apart. An ex-Army radio technician, factory trained, is in charge.

An engine test stand will soon be put in operation. An unusual installation on the apron outside the hangar is a wash rack built to handle nearly any type of aircraft. This rig consists of two permanent wooden scaffolds separated in the middle by enough space for the nose of the plane. Elevated platforms enable scrubbing the tops of wings. All ships brought in for major work are first thoroughly cleaned and washed down at the scaffolds before being brought into the hangar.

Operations have been concentrated on reconversion of surplus military aircraft. Although the base has been in operation only two months, 2 twin-engine Cessnas, 4 Convair BT-13s, 4 Boeing PT-17s and several Naval Aircraft Factory N3Ns have been completely over-



Much of Hawthorne Airmotive's current work is reconversion and complete rebuilding of war surplus planes, such as this Cessna UC-78.

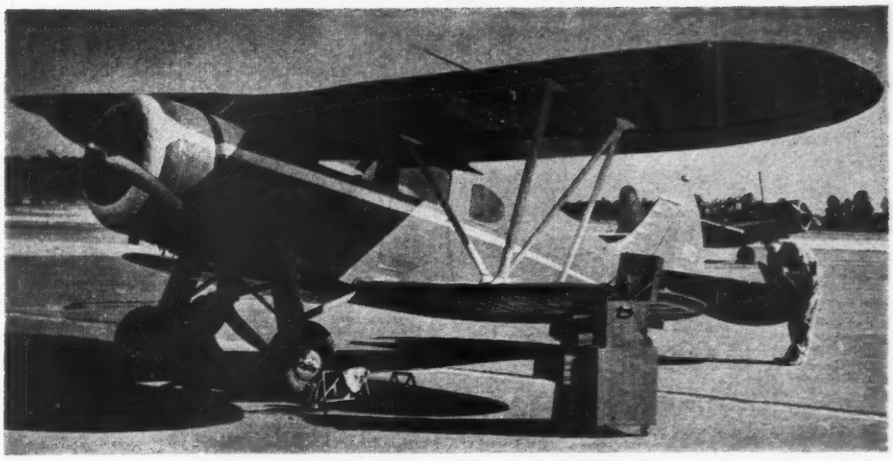
hauled in addition to engine and airframe work on numerous light craft. Virtually all shop personnel were employed at the field during the war on AAF maintenance work.

In addition to the faster work made possible by specialization of operations, Monschke is convinced that a large repair base can handle work at less cost to the customer than smaller shops. On the matter of flat rates he feels, however, that until there are a lot of new airplanes in operation, standardization of prices for 100-hr. inspections or engine work is neither good business nor the best answer for the customer. "Maintenance requirements on old prewar aircraft," he says, "vary so that the man whose plane has been well-kept and properly maintained, would pay more than he should if he paid an average price for a certain job in which we'd come out even."

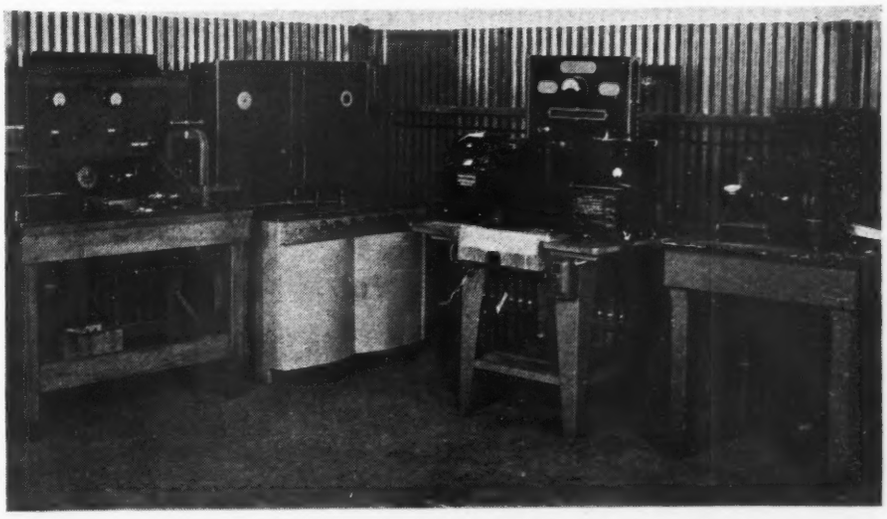
Viewing the future, Monschke is concentrating much of his organizational planning on providing speedier service, feeling that the future of successful repair operations depends almost entirely on good work turned out with a minimum of delay to the customer. He feels that production line maintenance, with which his crew had so much experience during the war, is one of the best methods of cutting costs. He also plans to borrow another wrinkle from wartime maintenance—a crew working nights so that an owner's plane won't be tied up during the money-making daylight hours. One typical example of time-saving equipment is the interphone and public address system enabling two-way communication from the maintenance office to the main hangar, the stock room, and the flight line.

In addition to providing service to the general public and operators in the vicinity, Hawthorne Airmotive also serves as a central repair depot for the 65 airplanes operated at the company's various bases. Although each of these have shop facilities, ranging from a complete repair station at Columbia to minor shops at the smaller bases, the larger overhaul jobs, such as airplane recovering and engine overhaul will gradually be centered in Orangeburg.

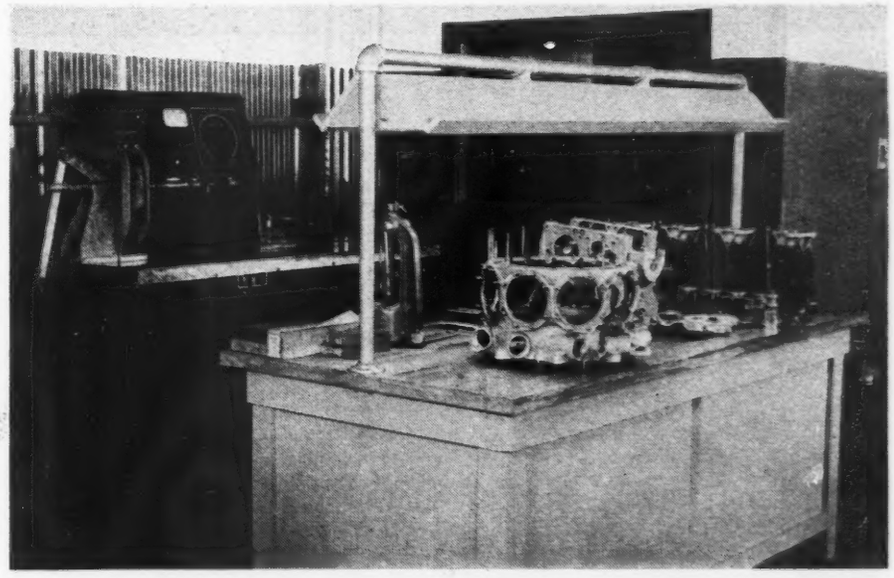
"The perpetuation of life" at Hawthorne Field is indeed encouraging in contrast to other now-deserted facilities which once were the spawning grounds of America's air power. As a central headquarters for Hawthorne's operations system, this field is unique in airport service operations and, as more and more planes come off the factory assembly lines, it will not doubt become an increasingly important center of private flying activity in this wide southeast service area.



Special line service crew handles spot repairs on transient planes, thus obviating interruptions of work being handled in shop. Wheeled tool box expedites mechanics' work.

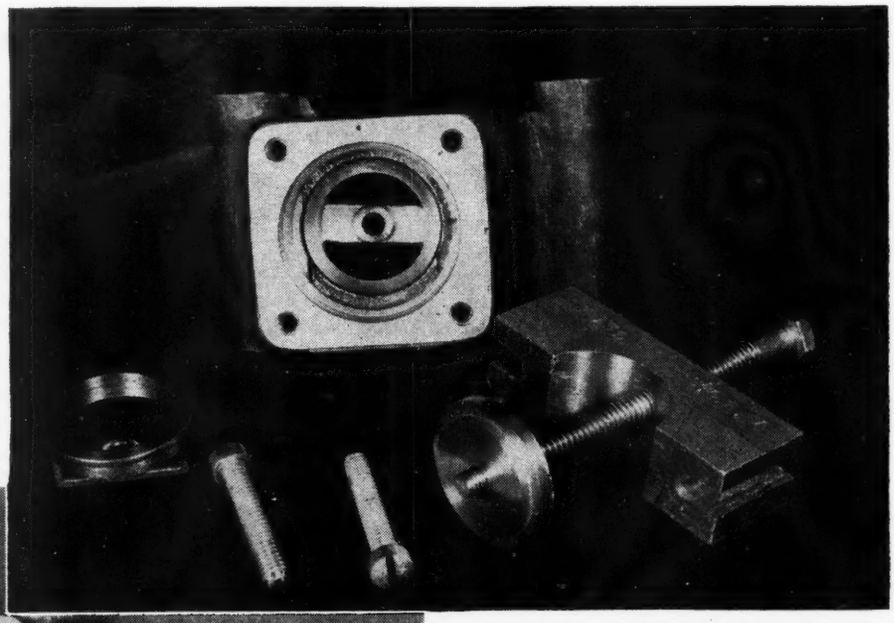


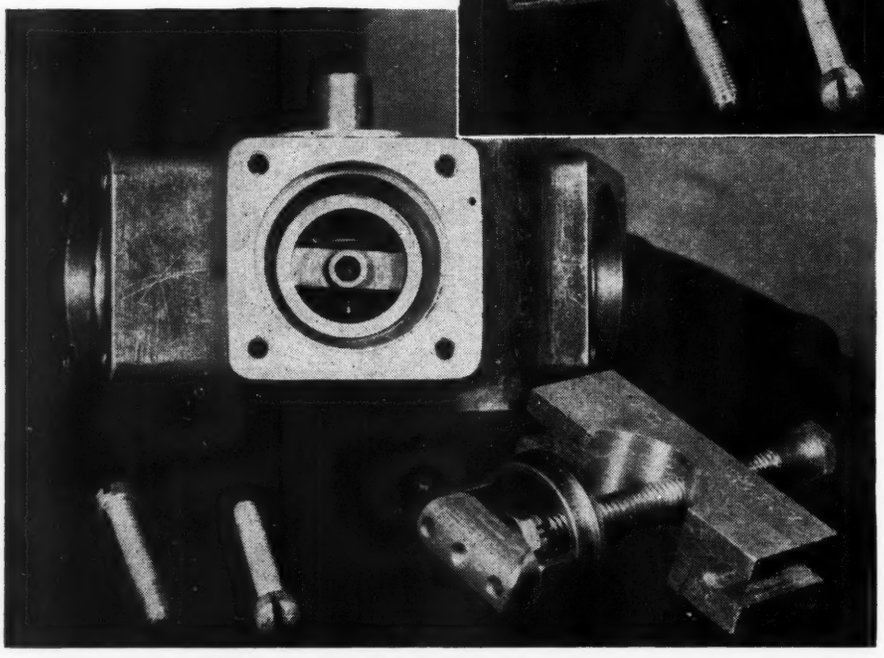
This section of Hawthorne Airmotive's accessory shop depicts various benches for working on magnetos, starters, and carburetors.

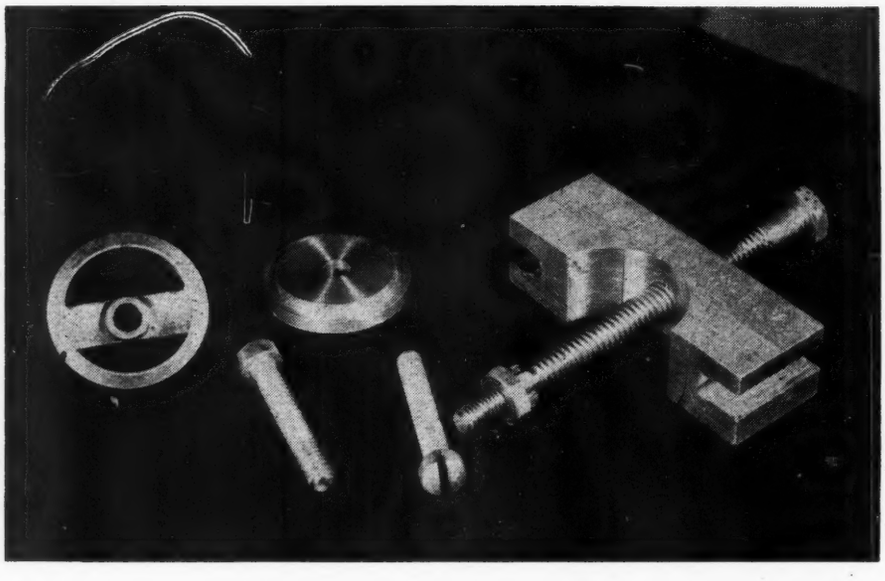


Portion of Hawthorne Airmotive's engine overhaul room showing slanted shelves above workbench to hold small tools.

Valve Bushing Tool Simplifies Installation





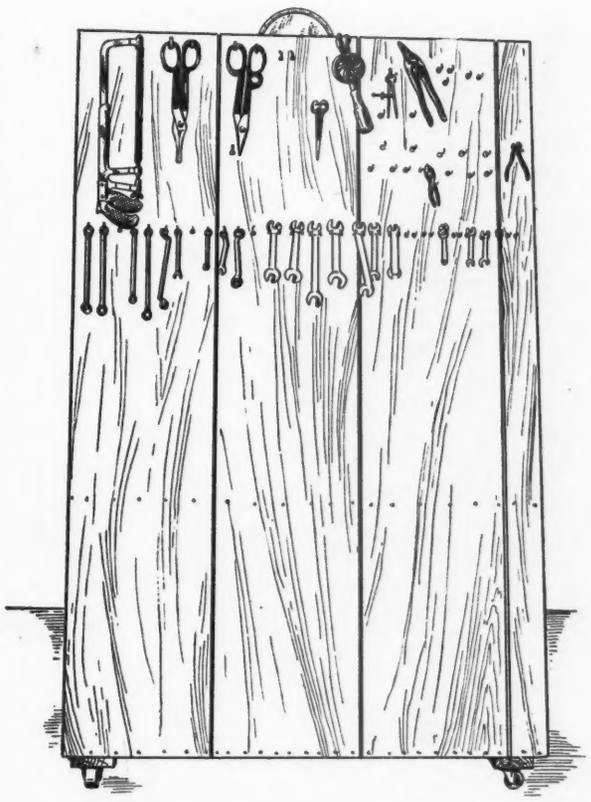


• In order to install and remove fuel selector and crossover valve bushings without damage, PAA's Miami shops built this special tool designed by Mechanic Fred Anderson. Tool consists of a block of aluminum alloy (lower left photo) through which passes a long screw for applying pressure to the bushing.

When removing a bushing, an oblong block is attached to central screw of tool below part to be removed (as in upper left photo), after which center screw is turned outward, drawing bushing with it.

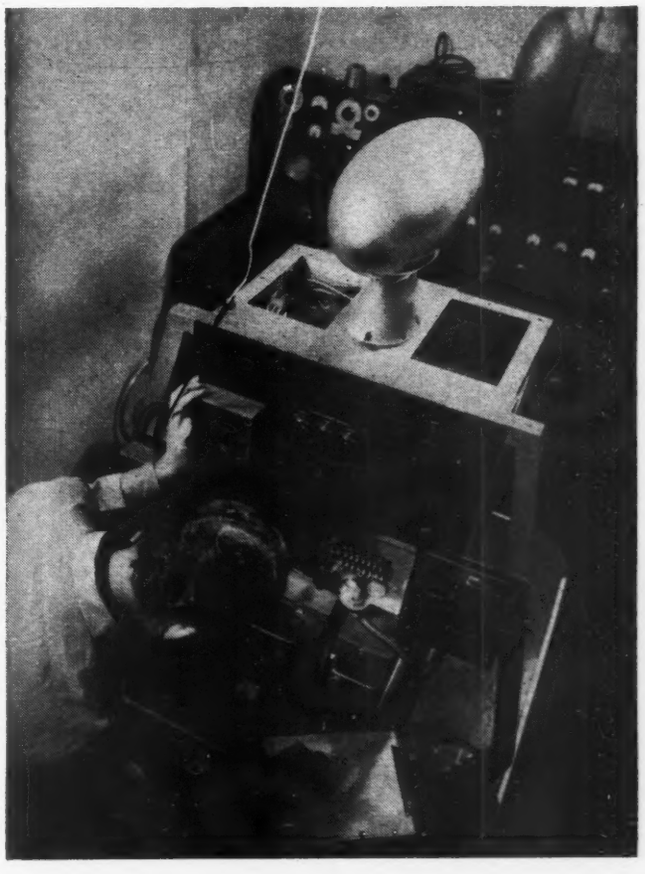
If a bushing is to be inserted (see upper right photo), a disk is placed on end of screw, serving as a means of applying pressure evenly and at same time preventing bushing from tilting and causing scratches in valve body.

Use of this device is stated to have saved about $18 monthly—a good return from a $3 tool.



Mobile Bench Carries Double Tool Supply

• To permit two mechanics to work simultaneously on a plane and its power plant, respectively, without interference or lost motion, Charles Grieder, of Martin's Creek Airport, Belvidere, N. J., devised this combination tool bench and rack. As shown here in rear-view sketch, flat back carries tools required for jobs about the plane. Meantime, bench and shelves (front view) are employed for engine and accessory servicing. It has been estimated that this bench saves an hour in each working day.



Specialized Test Stand Checks Radio Compasses

• Installed by EAL at Miami base, this test stand enables simulation of all flight conditions when checking automatic compasses before installation in airliners.

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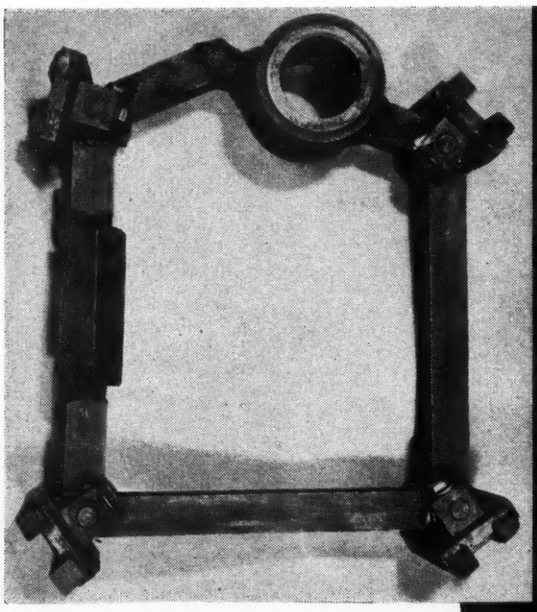
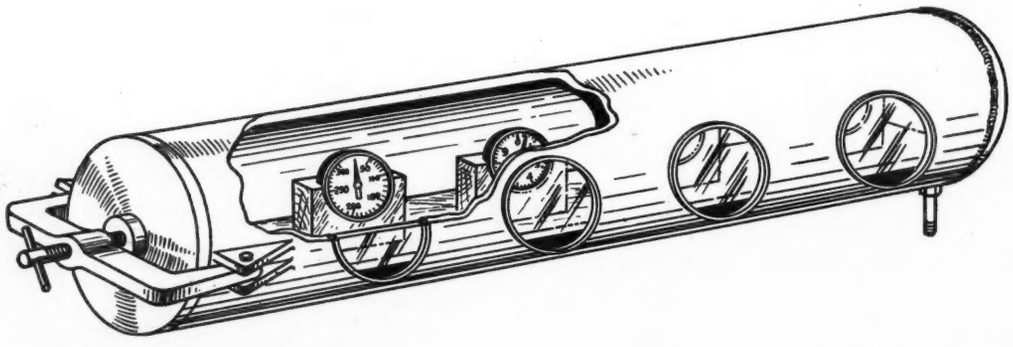


Flexible Brake Drum Hone Eliminates Many Replacements

• By means of a flexible mounting for brake drum honing, in place of conventional grinder, TWA's Kansas City shops prolong drum life to as much as 5,000 hr. Adjustable jointed arms completely finish interior of drum without removing more than one-third of material commonly ground out in former process. Machine was invented by Shop Foreman John B. Kelly, and it was built by Senior Mechanic John Hauck.



Instrument Pressure Chamber Fabricated From Iron Pipe

• Mechanics in Lehigh Aviation's Allentown, Pa., instrument shop made this altimeter and airspeed indicator test chamber from large iron pipe, with welded end and hinged access door. Instruments are placed in beds mounted on board, which is slid into chamber. Gasketed door (left) is closed tightly by handscrew to hold pressure or vacuum. Pipe (right) connects to compressor or vacuum pump.

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PRACTICAL ENGINEERING OF ROTARY WING AIRCRAFT

PART I

By **PAUL H. STANLEY,** *Chief Engineer, Autogiro Company of America*

In this first of a comprehensive series of analyses concerned with problems of rotorcraft design, the author presents details of fundamental knowledge gained from the development of the autogiro, outlines principles employed in successful 'copters, offers predictions bearing on future developments, and finally discusses important aspects of loads developed in hub-driven helicopter blades.

CONTRARY to widespread public belief, the helicopter did not originate in the 1940's. In fact, it is one of the oldest approaches to the problems of mechanical flight. Fifteenth Century drawings and notes of the versatile Leonardo da Vinci clearly show his thinking along the lines of helical airscrews on vertical axes. And in his comprehensive article on early rotary wing developments, Capt. Liptrot says, "The first helicopter actually to fly was a small model, little more than a toy, which was shown before the French Acadamie de Sciences in 1784 by Launay and Bienvenue; and since that time, literally thousands of schemes have been proposed by inventors all over the world. The patent files of all countries are full of helicopter specifications, the greater of them being based on faulty physical plans and obviously impractical."

The headline-making practical successes achieved during recent years in rotary wing flight have roots that extend far back in time. Much of this foundational record—particularly that as recent as the last 25 yr.—is worthy of more than casual interest. And a reasonably complete familiarity with the vast amount of rotative wing engineering, design, and development work done since the turn of the century is necessary to insure against needless waste of time, effort, and money.

The demonstration of practical flight of an autogiro by Juan de la Cierva in 1923 started a relative avalanche of rotorcraft development. Crux of this effort after more than 20 yr.—devoted in the main to autogiro type craft—is the foundation upon which today's rotary wing progress is largely based.

Literally translated, "autogiro" means self-rotation. The term "giro" does not imply gyroscopic phenomena, but gyration. It means to move in a spiral, to rotate or revolve. Self-rotation, as applied to the aerodynamic phenomena which causes a rotor system to turn without application of external power, is called autorotation.

Autorotation has long been known, adversely, to the aeronautical world through its manifestation in the form of spin, since most fixed wing aircraft were susceptible to this characteristic to a greater or less extent. However, the problem of spin is no longer one of major consideration to the airplane designer.

First practical autogiro embodied a freely rotatable rotor hub with blades set at autorotational pitch, also blade hinging which prevented excessive bending stresses, provided a balance of lift forces on the advancing and receding blades, and eliminated powerful gyroscopic effects.

Autorotation, as applied to an autogiro having blades set at a positive lift incidence within the autorotational range, is explained for vertical descent as follows: Consider the plane of the disk A-A, Fig. 1, formed by a system of rotating wings or blades set at a positive angle of incidence to A-A. In vertical descent, there is a small relative wind, V, perpendicular to the plane of

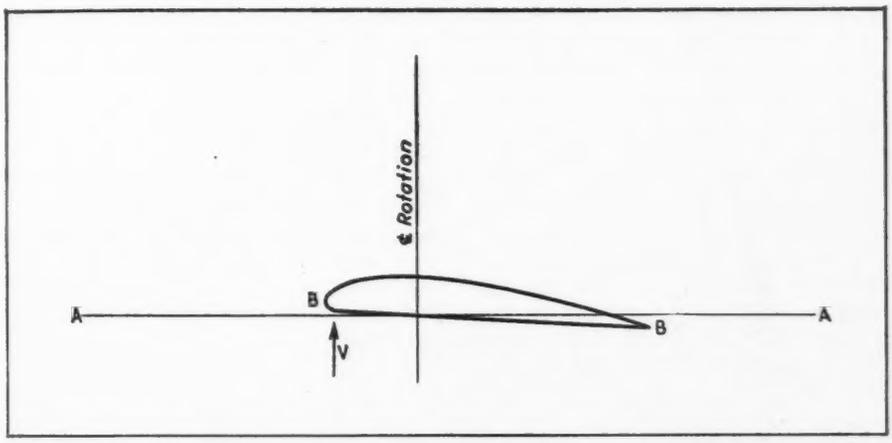

Fig. 1. Diagram of elementary blade section in autorotation.

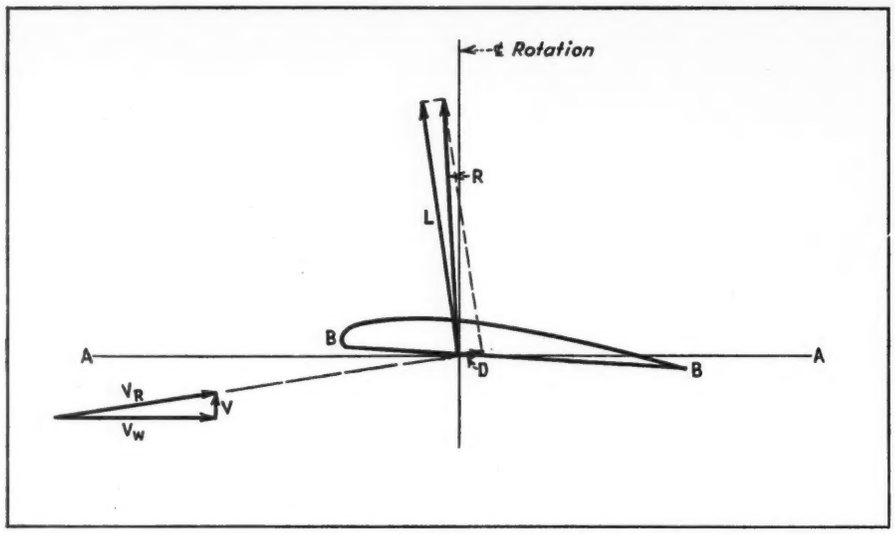

Fig. 2. Forces on elementary blade section in autorotation.

the disk. Centerline of rotation is also perpendicular to this disk.

Next, consider the blade B-B at right angles to the plane of the paper. As shown in Fig. 2, a resultant wind, *Vr*, is formed by the vectorial addition of the small relative wind, *V*, and the velocity of the blade's rotation, *Vw*. This resultant wind acting on blade B-B creates a lift, *L*, perpendicular to, and a drag, *D*, parallel to, the wind's line of action. The vectorial addition of the lift and drag gives a resultant force, *R*, acting ahead of the perpendicular to the disk A-A, causing blade B-B to rotate. Autorotation gives a high rotational speed, coming to a stabilized value when resultant force, *R*, is parallel to disk centerline of rotation.

The difference between autorotation and windmilling should be kept clearly in mind. Strictly speaking, a windmill type of operation exists when a flow of air displaces the blades of a windmill, with the blades set at such angle as to produce a ***minimum of thrust*** and a ***maximum torque*** delivery to the hub—essentially contrary to the autorotational action previously described. An illustration of the difference may be found by comparing the action of a flat plate used as a windmill vane with that of an airfoil blade of a lifting rotor. The airfoil blade, set at a positive angle, say 5 deg., to the plane of rotation, will autorotate and produce a substantial lifting thrust. The flat plate vane of the windmill, also set at a positive angle, will not autorotate, but will turn backward (as compared with the rotor) and produce a substantial torque with little thrust.

First practical autogiro did not have fixed wings, but did incorporate small movable control surfaces of a wing-like character. Experiments quickly led to the use of fixed wings which improved efficiency in forward flight, permitted the rotor to fly at a flatter angle, and provided other advantages.

Flapping hinges are an important factor in the successful operation of the autogiro—balancing the lift forces on the advancing and retreating blades when crossflow is introduced over the rotor disk. This balance of lift forces is accomplished by allowing the advancing blade to rise as it moves forward, with a consequence that this blade then works at a lower effective angle of attack at the faster resultant speed. These hinges also contribute to reduction of blade root stresses in the plane of flapping. Furthermore, through the use of blade root articulations, the gyroscopic mass is reduced to the negligible amount inboard the hinges, rather than that of the complete rotor.

Earliest Autogiros

In the earliest autogiros, the rotor was brought up to flight rotational speed by giving it an initial rotational speed (either by hand, through a quick turn of the aircraft, or by propeller slipstream in combination with elevators on the horizontal tail surface) and then taxiing across the field at a progressively increased speed, forcing air through the rotor disk, until flight rotational speed was attained. In 1925 Cierva incorporated a starter for the rotor, to set it in motion prior to takeoff. And he also devised a controllable mechanical transmission, with freewheeling arrangement to permit rotor to overrun the transmission for autorotational operation.

In 1930, the Autogiro Co. of America—in conjunction with Machine & Tool Designing Co. of Philadelphia—undertook an intensive development of the rotor mechanical driving system. From that time on, all autogiros incorporated a positive driving system for the rotor.

Early autogiros were of the fixed rotor type—rotor was attached to a rigid axis at the pylon apex, well above the fuselage. These craft also incorporated a small fixed wing—attached to the lower part of the fuselage—which furnished an ideal base for the wide-track main landing gear, carried the ailerons, kept rotor rotational speed practically constant throughout the normal speed range, and contributed to aerodynamic efficiency.

Fair stability was obtained in even the early autogiros. Exhaustive analyses and tests—concerning the type and location of fixed wings, upturned tips, auxiliary surfaces and relative positions of propeller thrust line, center of gravity, and rotor axis were conducted by company engineers. Stability and control were consistently improved. Some of the more successful of these early machines are shown in Figs. 3 to 6, inclusive.

Direct Control Autogiro

During development of the fixed wing type autogiro, control shortcomings and limitations became evident. After much consideration, Cierva found what he considered a satisfactory solution in a new type of autogiro in which both longitudinal and lateral control was accomplished by a tilting of the rotor vector resultant. As early as 1923, this principle had been used to achieve lateral control only (Fig. 7).

Principle of direct control as applied to any rotary-wing aircraft is based on movement of the vector, representing resultant thrust produced by the rotor, with respect to C.G. of craft. With direct control used in both longitudinal and lateral senses, resultant vector movement can be made with respect to C.G. in either of these two senses, either separately or in combination, so that pitching, rolling, or a combination of these moments will be produced in the craft. In the direct control type of craft, force of the rotor thrust (in steady flight) remaining fairly constant, moment to maneuver or control the aircraft is then practically proportional to movement of resultant thrust with respect to C.G., irrespective of translational speed of the craft. Direct control principle was first actually tried out by Cierva in the form of a tilting hub, considered by him to be simpler mechanically than his cyclic pitch control (the two being aerodynamically equivalent in the flapping or flexible rotor[1]). The full direct control system for lateral and longitudinal control, without fixed wings, ailerons and

[1]All references are collated at end of this article, page 65.

Table I—Structural and Performance Data of Outstanding Helicopters Since 1900
(From *Luftwissen*, Vol. 3, 1936, No. 5.)

Builder	Year Built	Number of Engines	Available Engine Power hp.	Number of Rotors	Rotor rpm.	Rotor Arrangement	Empty Weight, kg.	Rotor Thrust Developed, kg.	Rotor Dia., m.	Effective Swept Disk Area, m.²	Disk Loading, kg./m.²	Power Loading Required hp./kg.	Power Loading, kg./hp.	Highest Theoretical Power Loading Allowable, kg./hp.	Efficiency Obtained	Remarks
Dufaux	1905	1	3	4	....	Every two coaxial with opposite rotation.	17	23.5	2	6.3	1.44	.128	7.8	31.1	.25	Model tests with mooring and vertical guiding of model.
Lèger	1905	1	15	2	60	Coaxial, counter-rotation.	85	185	6.2	30.2	6.13	.081	12.3	15	.82	Successful slight lifting from ground with high load.
Cornu	1905–07	1	50	2	90	Side-by-side, counter-rotating.	190	260	6	56.6	4.6	.192	5.2	17.4	.3	Few cm. rise above ground — belt drive broke.
Brèguet I	1907	1	45	4	....	Biplane, two pairs of coaxial counter-rotating rotors, side-by-side.	500	620	8	201	3.08	.073	13.8	21.2	.65	First helicopter to rise above ground with one man.
P-K-Z I	1918	1	190	4	800	Side-by-side, with opposite rotation of each pair.	650	1,100	3.8/4.2	50.2	21.9	.173	5.8	8	.73	Three-cable mooring tested as stabilizing means.
P-K-Z II	1918	3	360	2	600	Coaxial, counter-rotating.	1,400	1,500	6	28.3	53.0	.24	4.17	5.13	.81	Stable hovering flight for ½ hr. at 50 m. with mooring.
Crocker-Hewitt	1918	1	126	2	100	Coaxial, counter-rotating.	.....	1,155	15.6	190	6.08	.109	9.17	15.2	.61	Design only available — only few rotor tests.
Perry	1920	1	36/86	2	60/80	Coaxial, counter-rotating.	545	785/1,418	11.6	106	7.42/13.4	.046/.061	21.8/16.4	13.8/10.2	(1.6)	Purely theoretical design only — impossible efficiencies given.
Berliner II	1920–22	1	80	2	....	Coaxial, counter-rotating.	280	410	5.5	23.8	17.2	.195	5.13	9	.57	Short flights carried out with one man. Special stabilizing surfaces applied.
de Bothezat	1922	1	220	4	....	Side-by-side, opposite rotation for each pair of rotors.	.....	1,700	7.6	182	9.35	.129	7.75	12.2	.64	Successful flight with two persons. Inherent stability because of great inertia.
Oehmichen I	1920	1	25	2	....	Side-by-side, counter-rotating.	336	265	6.4	64.4	4.11	.095	10.6	18.4	.58	Lifting power assured by addition of balloon which also was to stabilize craft.
Oehmichen II	1923–24	1	120	4	145	Side-by-side, opposite rotation each pair.	800	1,080	6.5/7.5	154.4	7.0	.111	9	14.1	.64	Stabilizing by auxiliary propellers. Successful circular flight of 1 km. length.
Pescara I	1920–22	1	45	2	150	Coaxial, counter-rotating.	600	360	6.4	32.2	11.2	.125	8	11.2	.72	Experiments unsuccessful, but led to further development of same model.
Pescara II	1922–23	1	180	2	....	Coaxial, counter-rotating.	850	900	7.2	40.6	22.2	.2	5	7.95	.63	Several flights successfully carried out with more efficient and better rotors.
Hellesen-Kahn	1925	2	150	1	100	Engine-propeller units on each of two blades of rotor.	800	800	13.	132	6.06	.187	5.35	15.2	.35	Few short hovering flights without further substantial success.
Baumhauer	1925–26	2	200	1	102	Torque-correcting propeller on fuselage.	1,300	300	15.2	182	7.13	.154	6.35	14	.47	Certain inherent stability due to gyroscopic effect. Only short tests.
Isacco	1920	3	60	1	....	Engine-propeller units on each of two rotor blades.	550	550	12.5	123	4.47	.109	9.17	17.7	.52	Tests without important success. Only small lift.
Asboth	1928–30	1	126	2	650	Coaxial, counter-rotating.	550	650	4.35	14.8	44	.194	5.15	5.64	.91	Several designs, shown in flight. Most successful helicopter of its time.
Ascanio	1930	1	95	2	....	Coaxial, counter-rotating, articulated rotor.	800	800	13.	132	6.06	.119	8.4	15.2	.55	Holder of several records — height, duration, and distance. Sufficient stability.
Florine	1923–33	1	160	2	240	Fore and aft rotors of same rotation, with inclined axes.	945	1,000	7.2	81.2	12.3	.16	6.25	10.6	.59	Several successful flights. Controllable stability.
Brèguet II	1930–36	1	230	2	....	Coaxial, counter-rotating, articulated rotor.	1,600	2,260	16.	201	11.2	.102	9.8	11.2	.88	Tests successfully concluded. Flights of considerable duration and distance carried out.

elevators—first tested by Cierva in early 1932—showed all the characteristics of improved control at low speed, with complete control throughout the speed range originally predicted by the inventor. Principles of the tilting hub direct control were also applied in the longitudinal sense in a 4,000-lb. American autogiro in late 1932. This control compensated for excessive center of gravity movement with variation in load, and the craft was capable of landing with longitudinal control being furnished only by controlled tilting of rotor hub.

As applied to autogiros of 1,000 to 2,000 lb. gross weight, original tilting hub system of complete direct control, as developed by Cierva, was entirely satisfactory. However, on scaling up this system to a direct control craft of over 3,000 lb. gross weight, a number of undesirable characteristics appeared —excessive control loads and rotor blade motions (both in a flapping sense and lead-lag of blades in plane of rotation). Principles involved in these problems, and their solutions, were presented in diagrammatic form in prepared testimony presented by Mr. Pitcairn before the House Military Affairs Committee in Apr. 1938.

Application of the solutions resulted in a type hub referred to as the modified centralized type—used with considerable success on various direct control autogiros from gross weights of 2,000-3,600 lb. Installation of semi-irreversible steering units in the control systems also played a large part in producing a hub control system, free from objectionable vibrations. Many of the principles of control and stability established for autogiros are directly applicable in the design of successful helicopters.

During 1936-37, a rotary wing design (using many of the fundamentals of the direct control autogiro) was conceived and constructed by Raoul Hafner and his associates. It employed the Cierva combination of flapping blades with pitch control. A considerable amount of flying was done with this craft, fully described in *The Aeroplane* Feb. 17, '37, *Flight* Feb. 18, '37, and by the designer.[2]

Direct Takeoff Autogiro

With control of the autogiro demonstrated down to and including zero forward speed, next important milestone was development of positive quantitative performance in the low or no-speed range. It had been demonstrated on numerous occasions that landings could be made in restricted areas, with little or no roll after contact with the ground. In 1932, it was proposed (by R. H. Prewitt) that the autogiro could be made to take-off directly (zero forward speed) by setting the individual rotor blades to zero lift pitch, obtaining rotational speed considerably in excess of normal flight rotational speed, declutching rotor starter, and setting blades to (or somewhat above) normal autogiro flight pitch. Cierva also made investigations along similar lines, and in Nov. 1933 he demonstrated an autogiro which would make true vertical ascents of a few feet, even in still air.

In following years, development work progressed on the direct takeoff autogiro. By 1936, sufficient progress had been made in England on a two-blade rotor (termed autodynamic rotor by Cierva) embodying the feature of direct takeoff, so that public demonstrations were held. For a number of reasons, the two-blade system was later replaced by a three-blader, and some (such as the C-40 direct takeoff autogiro) were procured by the Air Ministry.

British development of the direct takeoff autogiro consisted basically of those hinge configurations and linkages which would give the proper values of blade pitch for the sequence of operations involved in direct takeoff—blade-pitch set to zero lift under the action of rotor drive, going to above-normal flight pitch due to action of excess centrifugal force during first few seconds of direct takeoff, and returning to normal flight pitch with normal centrifugal force of normal flight. American version of this development included mechanical means to lock the blades at zero lift incidence during rotor acceleration, then to shift all blades quickly and uniformly to normal flight incidence. During first few seconds of direct takeoff, with rotor developing a considerable excess of rotational speed, a small increase of blade pitch above normal was obtained through hub configuration.

The first American direct takeoff tests were conducted, in Nov. 1935, on the PA-22 autogiro.

Development progress of the direct takeoff autogiro was both interesting and difficult. Solutions of many problems—particularly those of a mechanical nature—were especially trying, while analysis and cure of other difficulties were time-consuming and costly. Nevertheless, gratifying performance was demonstrated, time and again. That the direct takeoff autogiro did not go into commercial production was the result of a number of factors—including the situation that World War II had begun when this development was complete, and the helicopter, a logical development of the autogiro, was beginning to show promise.

Although worthwhile contributions were made in the field of helicopter experience prior to the '20s, these were relatively few and far between. Among the major problems on which little or no satisfactory progress had as yet been made were those relating to gyroscopic forces, unbalanced lift effects, inability to descend safely upon power failure, torque, instability, vibration, and dangerously inadequate or impractical control systems. However, in the years that followed the demonstration of practical flight by the autogiro, interest in the development of helicopters increased rapidly.

Even before entering actively into autogiro development, Harold F. Pitcairn and his associates studied the problems of the helicopter and constructed a number of models to test their ideas on this form of flight. In 1927, their studies and experiments culminated in successful flights of a torqueless helicopter model having a jet-driven rotor of the hinged type. With definite progress recorded in the helicopter field, Mr. Pitcairn concentrated his attention on the autogiro in 1928. As a result of this American sponsorship of the autogiro, developments in rotary-wing craft proceeded at an unprecedented rate during the next 15 yr.

A broad variety of development and experimental work was done by those working in the helicopter field prior to 1931, and much of this effort is admirably covered in an article by Capt. Liptrot in the *Journal of the Royal Aeronautical*

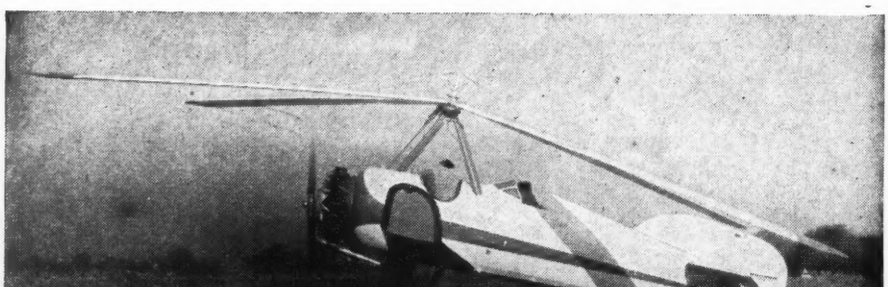

Fig. 3. Seen here is Pitcairn PCA-2 autogiro.

Fig. 4. Pitcairn PAA-1 autogiro.

Society, July 1931. He felt that a great deal of impetus had been given to the helicopter movement by Cierva's development of the autogiro, which possessed features of vital importance to 'copter-craft:

"(1) The difficulty due to the lateral overturning moments of a single screw in translation has been discussed. Cierva devised the exceedingly neat and effective plan of hinging the blades so that they could rise or fall independently under the influence of the air loads on them. All lack of balance due to forward motion is thus simply and adequately overcome.

"(2) The rotating system is perfectly stable.

"(3) The blades being freely hinged are not subjected to heavy bending moments, nor are the loads on the blades greatly influenced by accelerations, since the centrifugal loads are so much greater than the air loads.

"The blade structure is in fact mainly subjected to tensile loads, and an important truth not yet generally realized is that the structure weight of the hinged-blade rotating-wing aircraft tends to decrease with size instead of to increase, as is the case with the conventional aeroplane. It may thus eventually be possible to build big helicopters more economically as regards structure than big aircraft.

"(4) It has paved the way to safe forced landings by helicopters by showing the high parachutal value of the autorotating wing."

Table I lists 21 different helicopters and some of their essential features.

Current 'Copter Development

The past few years have seen tremendous strides in the development and use of the helicopter. While Breguet, in France, had some success with his coaxial, counter-rotating craft, first really promising helicopter was that made by H. Focke.[3] His rotors and controls were based directly on the Cierva autogiro, and his first craft made successful flights in 1937. This 'copter—FW-61—consisted of a fuselage with rudder and small fixed horizontal tail surfaces, the fuselage carrying the engine. A pair of hinged blade rotors, counter-rotating, were carried by the structure built out from each side of the fuselage, giving sufficient spacing between rotors so that downwash cleared the fuselage. Control and stabilizing was by utilizing the propeller blades themselves—cyclic pitch control. This craft successfully demonstrated the required change from helicopter to autogiro blade pitch in event of engine failure and on June 25-26, 1937, broke all existing helicopter records.

By 1938, the Focke organization was considering machines larger than the FW-61 (flown as a single-placer), which would have both commercial and military utility. The same general arrangement of a pair of laterally disposed counter-rotating twin rotors were considered for use on all larger and improved Focke helicopters. After 1938, because of the war, very little further information was available on Focke developments, but since the end of the war in Europe, it has been learned that at least one design of the large Focke-type 'copters was flying by about 1940. This was a craft of some 1,000 hp., using two laterally disposed, three-blade rotors of approximately 40 ft. dia. Gross weight was probably of the order of 7,500 lb. It is understood that a number of these machines were built, and that toward the end of the war, they were used for supplying troops in relatively inaccessible positions.

A helicopter development contemporaneous with that of Focke was conducted by the Weirs in Great Britain[4], who as licensees of Cierva Autogiro Co. Ltd., demonstrated in 1936, their W-3 direct takeoff autogiro. After much study of both direct takeoff autogiro and the helicopter, the W-5 single-place helicopter was designed and constructed as a flying laboratory and made more than 100 takeoffs and landings between 1937 and 1939, when it was superceded by the W-6—a two-seater flown in Oct. '39.

To eliminate the problem of torque correction, the Weirs used a pair of laterally disposed rotors. They also studied, designed, and tested certain components of a coaxial counter-rotating system, but "it was concluded, however, that this arrangement introduced so many aerodynamic and constructional difficulties that the side-by-side arrangement was finally selected."[4]

Gross weight of the W-5 was 840 lb. It incorporated a Weir 4-cyl. engine

Fig. 5. Pitcairn PA-18 autogiro.

Fig. 6. Kellet convertible cabin autogiro, Model K-2.

developing 50 hp. at 2,500 rpm. The 15-ft. dia. two-blade rotors were geared to turn at 410 rpm. The W-6 used an engine of 200 hp. (at 2,400 rpm.), had two 3-blade 25-ft. rotors operating at 275 rpm., and was 2,400 lb. gross weight. On October 10, '39, the W-6 made its first flight, and thereafter was flown frequently until July '40, when development was temporarily halted to release personnel for more urgent war work.

Much exact quantitative information was obtained on blade behavior in various flight conditions of the W-6. As one phase of these investigations, a motion-picture camera was mounted on the rotor hub (Fig. 8) and recorded blade-motions about the drag-hinge as well as various control movements. Neutral position for the conditions of blade pitch, power application, and rotor rotational speed used during these tests was shown to be a blade lag-angle of 9 deg. Minimum lag-angle was recorded as 4 deg., and maximum lag-angle was shown to have reached a value of 19 deg., for a diagonal movement of the control stick, first slowly and then with increased speed, giving ± 7 deg. cyclic pitch change combined with ± 3 deg. collective pitch change. Data obtained in these and other tests of W-5 and W-6 helicopters are being used as the basis of more development in Great Britain under the direction of the Cierva Autogiro Co.

First officially recorded helicopter flight by Igor I. Sikorsky[4] was on Apr. 15, 1941. He had, prior to 1910, experimented in Russia with helicopter problems, and is known to have constructed at least two early experimental craft—the second being completed in May, 1910. The craft appears to have had a pair of three-blade coaxial rotors, probably counter-rotating. Mr. Sikorsky, who long ago attained outstanding success in the field of fixed-wing aircraft, apparently gave consideration to problems of rotary-wing flight during the years of autogiro development. His experimental helicopter—the VS-300—was flight-tested with numerous modifications, prior to the time of his officially recorded flight in 1941.

Sikorsky 'copters are reported to be the first to roll off a production line and the only such rotorcraft to see active military service for the U. S. In addition to being used for training hundreds of pilots in the AAF, Coast Guard, Navy, RAF, and Royal Navy, Sikorsky helicopters were in action in England, Alaska, China, Burma, India, the Philippines, and on Army floating repair bases in the Southwest Pacific.

The Kellett XR-8—designed by R. H. Prewitt and produced by Kellett Aircraft Corp.—has achieved considerable success recently. This craft has a gross weight of approximately 3,000 lb., and derives lift from a pair of intermeshing three-blade rotors, each 36-ft. in dia., spaced 4 ft. between centers. This ship is exceedingly maneuverable, and a substantial number of flying hours, including cross-country flights, have been logged.

Bell Aircraft Corp., in experiments with helicopters designed by A. M. Young, have had much success with some models. Chief feature of these machines (using two-blade main lifting rotors, with a torque-correcting tail rotor) is a stabilizing bar which gives certain features of automatic stability to main rotor. Bell machines have already demonstrated their utility in rescue and mercy missions.

G&A Aircraft (Div. of Firestone Tire & Rubber Co.), successor to Pitcairn Autogiro Co., produced a single-rotor helicopter—the XR-9—for the AAF. Novel features of the craft are in the hub design—a modification of the aerodynamically stable rotor, as originated by J. & G. Weir for the W-6, and further developed by Autogiro Co. of America[5]. A considerable amount of test flying has been done, with indications of unusual freedom from vibration.

The Platt-LePage 'copter, with two laterally-disposed rotors carried on outboard supporting structures, has undergone a number of test flights.

Largest successful helicopter to date is the PV-3, produced by P-V Engineering Forum (now Piasecki Helicopter Corp.) under Navy sponsorship. The craft is novel in that it has demonstrated first successful use of the tandem rotor configuration, with counter-rotation for counter-action of rotor torque. Rated loading is pilot, co-pilot, and ten passengers. Power plant develops 450 hp. at takeoff. Rotors are approximately 40 ft. in dia.

Other Rotary Wing Developments

Another type of powered-rotor craft which has been proposed is the gyrodyne. In this type, torque correction for the main lifting rotor is by propeller offset laterally from craft's plane of symmetry, rather than by the tail torque-correcting rotor. With approximately 2/3 total power available delivered to the main lifting rotor, and 1/3 to the laterally disposed propeller, proponents claim that it has advantages in performance over a helicopter with tail torque-correcting rotor, since the torque-correcting propeller, in forward flight, is a source of useful thrust, whereas the tail rotor is a source of parasite. From engineering studies, it is believed the gyrodyne would be deficient to the true helicopter in low-speed performance, deficient with respect to the autogiro in high-speed performance, but with a slight superiority in performance over either if speed-range is taken into consideration.

Another type given some consideration is that referred to as the heliodyne. This type incorporates one main lifting rotor absorbing approximately 50% of total power available, with a pair of laterally disposed controllable pitch propellers, which can be set at a differential of thrust to give torque correction for any speed.

From investigations made by the Autogiro Co. of America on helicopter problems, there seems to be great ultimate promise in single-rotor 'copter employing some form of torqueless drive for the rotor, such as the blade-mounted reaction jets in Mr. Pitcairn's 1927 developments. Dr. Cierva also felt that the most successful single-rotor helicopter would not be developed until satisfactory jet-propulsion means were available. With the development of various

forms of jet propulsion in recent years, it is logical to expect the development of satisfactory small jet units which can be mounted on each rotor blade to furnish the required torqueless drive.

Jet propulsion holds real possibilities for improvement in present-day rotary wing design, leading to lower first-cost, increased serviceability, and greater value per dollar. Most important of these factors is elimination of the heavy, expensive internal combustion engine, which will greatly reduce structural and space considerations required for dead loads. Power transmission apparatus, normally required between engine and rotor, can also be eliminated, and preliminary calculations indicate that transmission weight savings alone will more than equal the weight of required jet units, feed lines, control units, and jet fuel tanks.

In the present stage of development of the rocket-type jet units using dual fuels (oxidizer carried), fuel consumption rate is admittedly high, and the resulting design, carrying 30% of takeoff gross weight as fuel, will necessarily be a short-range affair with flight duration of from 15 to 30 min. and range of 25 to 45 mi. Preliminary calculations again indicate a possibility of a two-passenger arrangement with takeoff gross weight of about 1,100 lb., as against present two-passenger 'copter weights of very nearly double this figure. From present-day progress in jets, it appears that the need for carrying oxidizing fuel will soon be eliminated—greatly increasing possibilities of flight duration.

The use of jet-drive for the rotor also points to an important possibility of simplification in hub designs. Through proper hub configuration, upon temporary cutting or permanent loss of power, the proper blade pitch for autorotation is obtained through reduction of peripheral speed and increased coning angle. This would also permit the use of Cierva's tilting type control rather than his cyclic pitch control, with resultant mechanical simplification. Thus, it appears that the future torqueless single rotor helicopter with jet units on each blade, will be lighter, simpler, and far more economical than today's type of hub-driven helicopter.

Most promising intermediate step to the completely jet-driven helicopter is that of an autogiro using assisted takeoff and retarded landing via rocket-type jets at the blade tips. Even with present high fuel rates, it appears that sufficient fuel could be carried to permit two or three brief periods of true helicopter operation during flight. In this form of flight, we would have all the simplicity and proven flying qualities of the latest direct control autogiro for 99% of airborne time, with the valuable assistance of jet drive available when needed. This is sufficiently akin to the already proven direct takeoff, so that there is no reasonable doubt as to the success of its operation. A calculation made for a hypothetical craft indicates that the weight of present rotor mechanical drive and direct takeoff mechanism is somewhat greater than the weight required for the jet installation, piping, tankage, and fuel to obtain the proposed assisted takeoff, two or three brief periods of true helicopter operation, and retarded landing.

Performance calculations on this same hypothetical craft, with power furnished by rocket-type jets delivering 82.5% normal engine power at operating rotor speed, show a maximum rate of climb, as a helicopter, of over 600 ft./min. at 40 mph. forward speed. Maximum rate of climb as an autogiro, at full engine power, is slightly under 600 ft./min. at 65 mph. With both the blade tip jets and engine operating at full power, maximum rate of climb of over 2,000 ft./min. is obtained.

Hub-Driven 'Copter Blade Loads

Many of the loads imposed on helicopter blades are identical to, and determined in the same manner as, corresponding loadings for an autogiro blade. This is especially so in power-off flight of the helicopter, since the lifting rotor then functions exactly as an autogiro rotor. In powered flight of the helicopter, bending moments in the plane of lift may be derived in precisely the same manner as the corresponding moments for an autogiro blade, making proper corrections to lift-distribution diagrams for any departure of a helicopter blade from rectangular planform, for either wash-in or wash-out of blade incidence, and also taking into account actual weight distribution of the blade under investigation.

Derivation of loads in the helicopter blade in plane of rotation, at the first instant of starting, will also be similar to the method of analysis used for the autogiro, since in the latter case, it is assumed that each blade is against its drag-hinge stop, also that rotor starting torque is reacted by blade inertia and combined with blade flapping loads in the plane of lift. It is entirely conceivable that in starting the helicopter rotor in gusty weather, a blade could be subjected to identical loads imposed on an autogiro in similar condition.

Main difference between helicopter and autogiro blades is that, in flight, a steady driving torque is applied to the helicopter rotor. Sufficient freedom is usually provided about the drag-hinge so that when designed rotor rotational speed and blade pitch are attained, the blade is off the drag hinge stop, and operates in equilibrium (at a considerable lag-angle) under the action of centrifugal force, blade drag, and force applied at the drag hinge resulting from driving torque. This condition of equilibrium is analogous to that for the blade with reference to the plane of lift, since the components of centrifugal force comprise the main restoring force in each case, with a drag distribution diagram replacing the lift distribution diagram, and also, the force at the drag hinge (resulting from driving torque) replacing the vertical component of centrifugal force at the flapping hinge.

Many years ago, in our discussion with Cierva of the problems of drag distribution along a rotor blade, he recom-

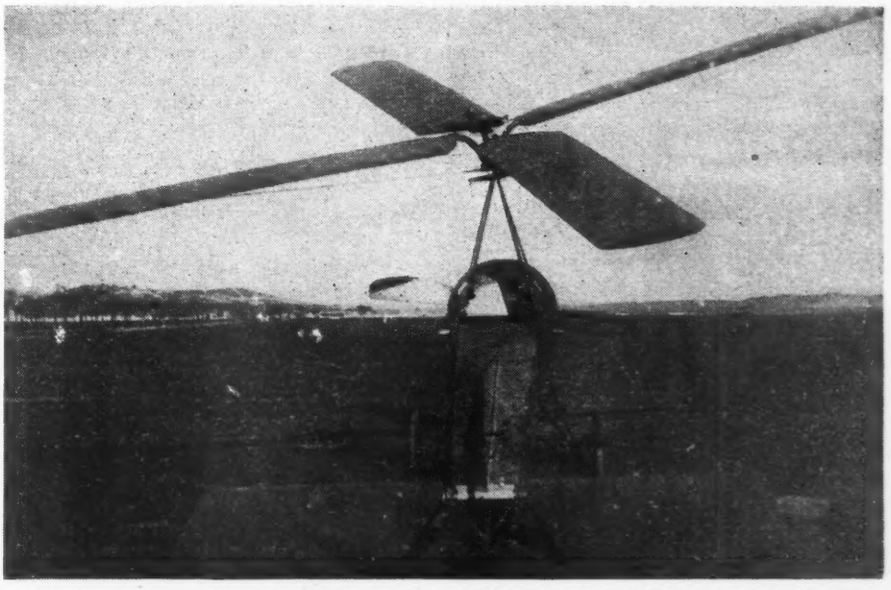

Fig. 7. One of first autogiros to incorporate lateral rotor control (about 1923).

Table II — Calculation of Relative Drag Distribution on Hub-Driven Helicopter Blade

ψ = 90 deg. and 270 deg., μ = .5

	ψ = 90 deg., C_D = .015			ψ = 270 deg., C_D = .25		
% R	Rel. vel.	(Rel. vel.)^2	(Rel. vel.)$^2 \times C_D \times A$	Rel. vel.	(Rel. vel.)^2	(Rel. vel.)$^2 \times C_D \times A$
7.5	1.15	1.32	.025	−.85	.721	−.228
15	1.30	1.69	.064	−.70	.49	−.309
25	1.50	2.25	.085	−.50	.25	−.158
35	1.70	2.89	.110	−.30	.09	−.057
45	1.90	3.61	.137	−.10	.01	−.0063
55	2.10	4.41	.167	.10	.01	.0063
65	2.30	5.29	.200	.30	.09	.057
75	2.50	6.25	.237	.50	.25	.158
85	2.70	7.29	.276	.70	.49	.309
95	2.90	8.41	.319	.90	.81	.511

Table III — Calculation of Torque absorbed by Hub-Driven Helicopter Blades

ψ = 90 deg. and 270 deg., μ = .5, R = 241.5 in.

	ψ = 90 deg.		ψ = 270 deg.	
% R	(Rel. vel.)$^2 \times C_DA$	(Rel. vel.)$^2 \times C_DA \times$ Arm	(Rel. vel.)$^2 \times C_DA$	(Rel. vel.)$^2 \times C_DA \times$ Arm
7.5	.025	45	−.228	−4.13
15	.064	2.31	−.309	−11.16
25	.085	5.10	−.158	−9.53
35	.110	9.34	−.057	−4.84
45	.137	14.86	−.0063	−.68
55	.167	22.20	.0063	+.84
65	.200	31.50	.057	8.95
75	.237	42.90	.158	28.6
85	.276	56.70	.309	63.4
95	.319	72.40	.511	117.2

mended that this distribution be considered as proportional to velocity squared—generally accepted now as an index of blade drag distribution. For the symmetrical condition of $\mu = 0$, there would be no variation of blade pitch throughout the cycle of operation, and consequently, the determination of bending moments in plane of rotation in function of blade radius is a relatively easy set of calculations. In going to $\mu > 0$, both the velocities and the blade pitch on the advancing and retreating blades vary considerably (but in a manner tending to equalize blade drag).

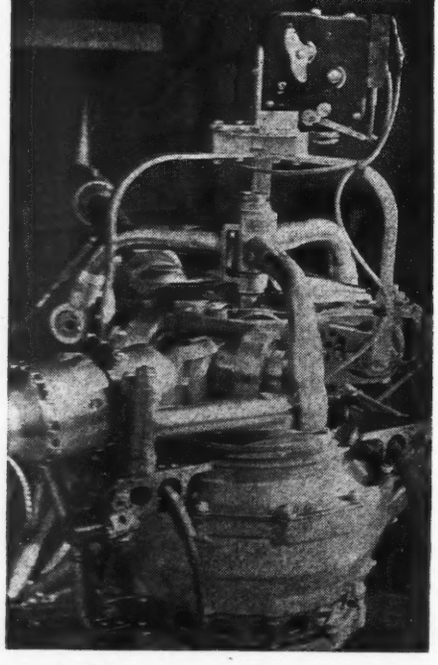

Fig. 8. Setup of movie camera mounted on hub of W-6 helicopter rotor for purpose of obtaining blade motion about drag hinge.

Cierva's conception of the virtual rotor —with centerline of rotation a distance μR on retreating blade from constructional centerline of rotation, and with drags at blade tips arbitrarily assumed equal—is useful as a first approximation in determining drag distribution.

A more accurate estimate of drag distribution for a three-blade rotor may be made by a determination of instantaneous angles of an advancing and a retreating blade, and assuming (as Cierva did for a three-blade rotor when considering lift distribution) that two-thirds of total torque transmitted by the hub would be absorbed by these two blades, at the angles determined, with *relative* drag as determined by instantaneous angles and squares of velocities. For example, a hub-driven helicopter type is examined for powered flight condition at $\mu = .5$, with gross weight of 2,100 lb., three-blade rotor of 40.25-ft. dia., 191 hp. to rotor at 190 rpm., and solidity = .06. The bending moments in plane of lift, for $\psi = 90$ and 270 deg., at $\mu = .5$, having already been calculated, the bending moments in plane of rotation, for $\psi = 90$ and 270 deg., at $\mu = .5$, will be determined, and the final bending moments to which the blade spar will be subjected will be the vector sum of moments in plane of lift and plane of rotation.

Blade pitch θ for $\psi = 90$ and 270 deg., at $\mu = .5$, will be calculated, using data from performance estimates on this craft. Value of θ_0, for $\mu = .4$, is 13.5 deg., and for $\mu = .5$, a value of θ_0 of 14.5 deg. will be used. Likewise. λ, for $\mu = .4$, is .089, and a value of .095 will be used for $\mu = .5$. Angle of blade oscillation (Eq. 14, Ref. 6) is calculated (for $\mu = .5$) as:

$$\theta_1 = \frac{8}{3} \times .5 \times \frac{.253 - .071}{1.375} =$$

.176 rad. = 10.05 deg.

Using a value of θ_0 of 14.5 deg., and θ_1 of 10 deg., the instantaneous value of blade pitch for $\psi = 90$ deg. is 14.5 − 10 = 4.5 deg., and for $\psi = 270$ deg., 14.5 + 10 = 24.5 deg. Using blade pitch equal to section angle of attack above zero lift, the drag coefficient (for NACA 23015 airfoil, Fig. 4, Ref. 7) is, for $\theta = 4.5$ deg. above zero lift, .0150, and for $\theta = 24.5$ deg., C_D = .25 (approx.). Drag distribution is calculated (Table II) and is shown graphically in Fig. 9 for the blade of solidity .06, which has a chord of 1.265 ft. From the table and graph, the relative torque absorption of the two blades is calculated (Table III) and shown graphically in Fig. 10. Taking total torque absorbed for the two blades as the sum of the areas in Fig. 10, and assuming that two-thirds of the total torque corresponding to 191 hp. at 190 rotor rpm., or 2/3 × 5,290 = 3,520 lb.-ft., is represented by the combined area of 5.59 sq. in., it is found that 1 sq. in. of area of diagram represents 630 lb.-ft. torque. The blade, at $\psi = 90$ deg., with an area of diagram of 3.23 sq. in., therefore absorbs 2,035 lb.-ft. torque, while at $\psi = 270$

Table IV — Determination of Elementary Forces Acting on Hub-Driven Helicopter Blades in Plane of Rotation (μ=.5)

Rotor hp. = 191 at 190 rotor rpm.

	ψ = 90 deg.			ψ = 270 deg.		
% R	Δf_D	Δf_i	Δf_R	Δf_D	Δf_i	Δf_R
7.5	−.24	3.86	3.62	+1.88	2.8	4.68
15	−1.22	5.13	3.91	+5.10	3.74	8.84
25	−2.69	8.12	5.43	+4.35	5.91	10.26
35	−4.93	11.3	6.37	+2.21	8.25	10.46
45	−7.82	14.52	6.70	+.31	10.58	10.89
55	−11.69	17.7	6.01	−.38	12.94	12.56
65	−16.58	21.0	4.42	−4.09	15.26	11.17
75	−22.60	24.1	1.5	−13.0	17.58	4.58
85	−29.90	27.4	−2.5	−28.9	19.9	−9.0
95	−38.7	24.7	−14.0	−53.5	17.3	−36.2

Centroid of torque distribution diagram (Fig. 10) at .748 R

Equivalent drag = $\frac{2{,}035 \times 12}{240 \times .748}$ = 136.0 lb.

1 sq. in. of torque distribution diagram = 136.0/3.23 = 42.1 lb. drag.

Centroid of torque distribution diagram (Fig. 10) at .862 R

Equivalent drag = $\frac{1{,}485 \times 12}{240 \times .862}$ = 86.0 lb.

1 sq. in. of torque distribution diagram = 86.0/2.3575 = 36.5 lb. drag.

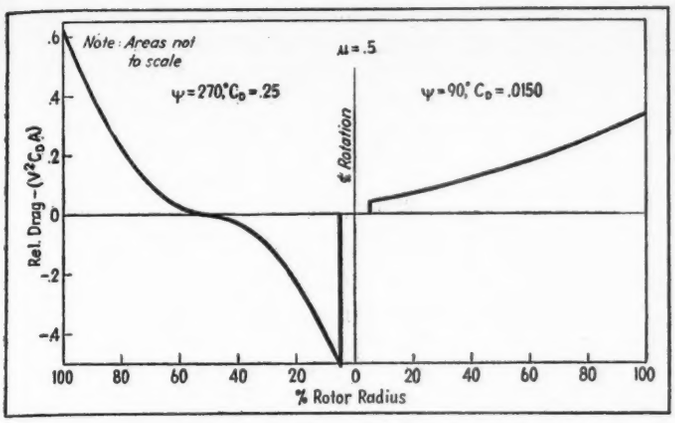

Fig. 9. Graph of relative drag, hub-driven helicopter blades.

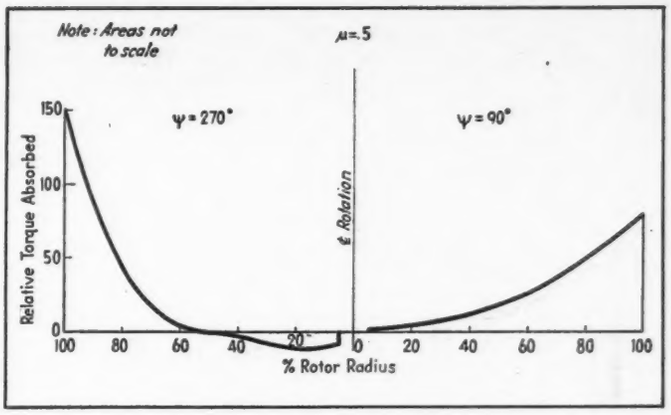

Fig. 10. Relative torque distribution, hub-driven helicopter blades.

deg., the blade absorbs 1,485 lb.-ft. torque—that is, the *retreating* blade appears to absorb less torque than does the advancing blade.

Using a drag hinge offset of 7.75 in., the side force required at the drag hinge to absorb the 2,035 lb.-ft. torque absorbed by the blade at $\psi = 90$ deg., is $2{,}035 \times 12/7.75 = 3{,}150$ lb., and for $\psi = 270$ deg., required drag hinge side force is $1{,}485 \times 12/7.75 = 2{,}300$ lb. Centrifugal force developed at the blade root, at 190 rotor rpm., is (for blade weight of 67.2 lb., and blade C. G. 8.72 ft. from center of rotation): C.F. = $19.9^2 \times 67.2/g \times 8.72 = 7{,}200$ lb.

Equilibrium position for the blade at $\psi = 90$ deg. (neglecting any lag in phase between position of application of set of forces and blade response) is at a lag angle $\Delta\psi = -26.00$ deg.; and with the blade at $\psi = 270$ deg. the lag angle is $\Delta\psi = -18.6$ deg. For a tip speed ratio $\mu = 0$, with torque evenly distributed to all three blades, the lag angle is -22.3 deg., showing that, at $\mu = .5$, there is a movement of each blade about the drag hinge, for the rectangular blade considered, of the order of -3.70 deg., and $+3.7$ deg.,

Table V — Calculation of Normal Resultant Bending Moments in Helicopter Blade μ .5; W, 2,100 lb.; Rotor dia., 40.25 ft.; Rotor hp., 191; Rotor rotational speed, 190 rpm.; 1¾-in. o.d. by .095 steel spar

	ψ = 90 deg.						ψ = 270 deg.					
% R	Primary bending moment, M_p plane of lift, lb.-in.	Relief bending moment, M_r lb.-in.	Bending moment in plane of lift, M_f lb.-in.	Primary bending moment in plane of rotation, M_{PR} lb.-in.	Bending moment in plane of rotation corrected for flexibility, M_{fPR} lb.-in.	Resultant bending moment, $M_{fRes.}$ lb.-in.	Primary bending moment, M_p plane of lift, lb.-in.	Relief bending moment, M_r lb.-in.	Bending moment in plane of lift, M_f lb.-in.	Primary bending moment in plane of rotation, M_{PR} lb.-in.	Bending moment in plane of rotation corrected for flexibility, M_{fPR} lb.-in.	Resultant bending moment, $M_{fRes.}$ lb.-in.
5	−1,750	2,500	−1,396	250	240	−1,417	500	2,000	410	450	428	593
15	−5,870	8,000	−3,245	700	612	−3,305	1,360	6,000	810	1,300	1,130	1,390
25	−8,800	12,500	−3,750	1,050	860	−3,845	1,850	9,000	967	1,900	1,550	1,830
35	−10,000	16,670	−3,720	1,275	982	−3,845	2,800	12,000	1,263	2,300	1,775	2,180
45	−9,750	20,000	−3,225	1,350	993	−3,375	3,350	13,750	1,400	2,450	1,820	2,295
55	−8,500	21,000	−2,725	1,250	906	−2,875	2,950	15,000	1,175	2,400	1,740	2,100
65	−6,500	21,000	−2,085	1,025	746	−2,215	1,700	14,500	690	2,000	1,460	1,620
75	−3,880	18,500	−1,352	700	525	−1,450	500	13,000	216	1,350	1,020	1,040
85	−1,500	13,000	−649	300	244	−694	−150	9,000	−79	550	450	460
95	0	5,000	0	0	0	0	0	3,500	0	0	0	0

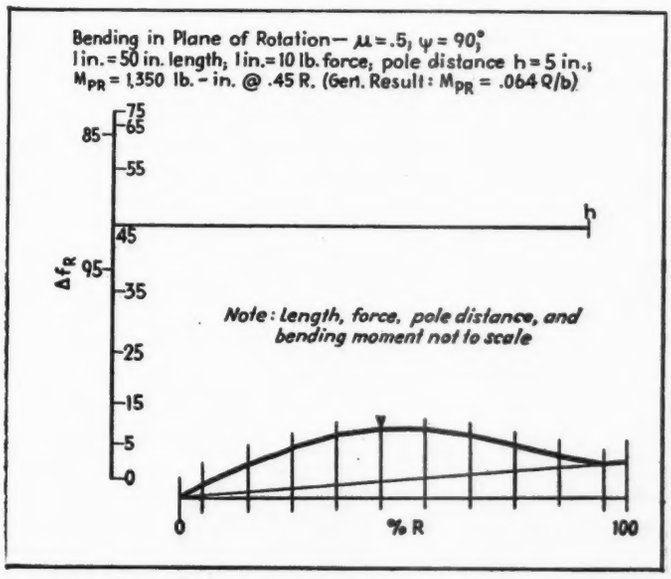
Bending in Plane of Rotation— μ=.5; ψ=90°
1 in.=50 in. length; 1 in.=10 lb. force; pole distance h=5 in.;
M_PR=1,350 lb.-in. @ .45 R. (Gen. Result: M_PR=.064 Q/b)
Note: Length, force, pole distance, and bending moment not to scale
% R

Fig. 11. Derivation of bending moment in plane of rotation, hub-driven helicopter.

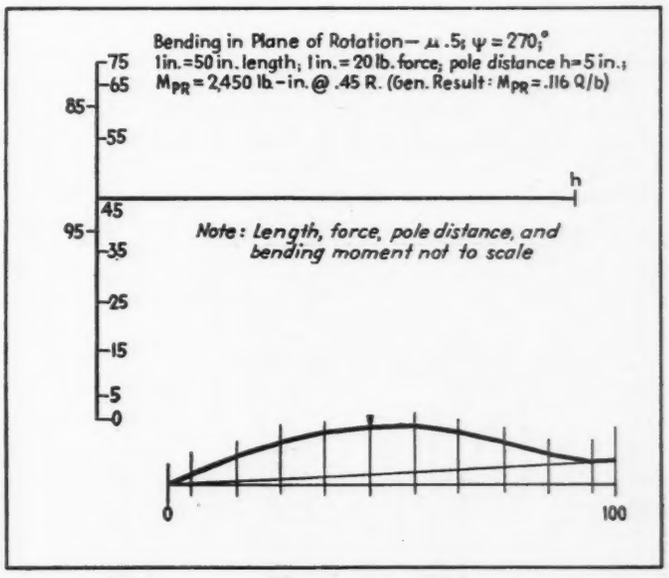
Bending in Plane of Rotation— μ .5; ψ=270°
1 in.=50 in. length; 1 in.=20 lb. force; pole distance h=5 in.;
M_PR=2,450 lb.-in. @ .45 R. (Gen. Result: M_PR=.116 Q/b)
Note: Length, force, pole distance, and bending moment not to scale

Fig. 12. Derivation of bending moment in plane of rotation, hub-driven helicopter.

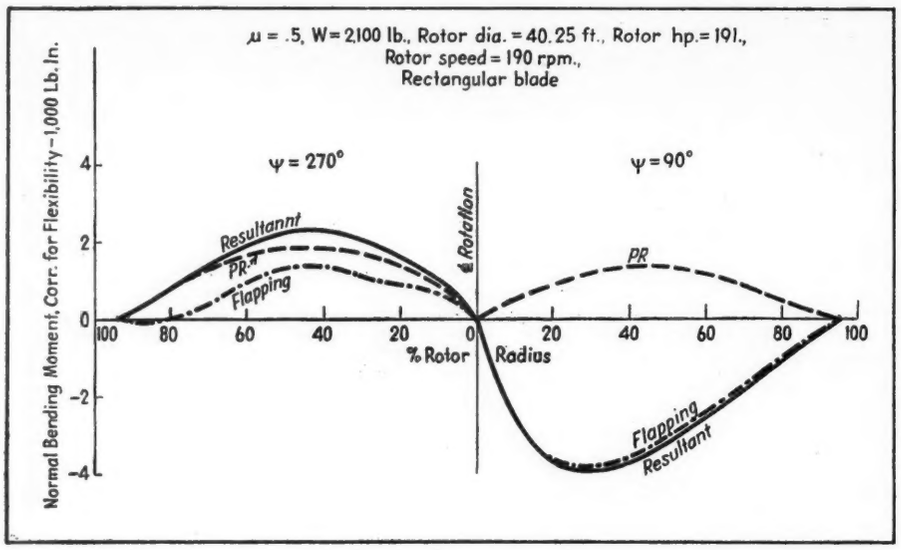

Fig. 13. Bending moments in helicopter rotor blade, corrected for flexibility—normal applied loads.

from the position at μ equals zero.

With torque distribution established, the elementary forces of drag, components of centrifugal force, and resultant force, are determined for each increment of blade radius (Table IV). These elementary forces are then used to determine the magnitude and distribution (in function of blade radius) of the primary bending moments in plane of rotation (Figs. 11 and 12). From Fig. 11, it appears that the maximum primary bending moment, in plane of rotation is 13.5% that in plane of lift (from calculations not shown here) for $\mu = .5$, $\psi = 90$ deg., while, from Fig. 12, moment in plane of rotation is also somewhat less than that in plane of lift. Also, since in plane of rotation, calculation of relief from primary bending because of blade flexibility would involve *lag-angle* rather than coning-angle (using relief bending moments from other calculations), it is found that bending in plane of rotation, added vectorially to that in plane of lift, gives a considerably increased final bending moment.

Maximum bending moments in plane of rotation, corrected for blade flexibility, are, for $\mu = .5$, $\psi = 90$ deg., with lag angle of 26.0 deg., and using flexibility factor $K = 2{,}140$ lb.-in. per deg., as follows:

$$M_{fPR} = \frac{1{,}350}{1 + \dfrac{20{,}000}{2{,}140 \times 26.0}} = \frac{1{,}350}{1 + .36}$$

$$= 993 \text{ lb.-in.}$$

And for $M = .5$, $\psi = 270$ deg.,

$$M_{fPR} = \frac{2{,}450}{1 + \dfrac{13{,}750}{2{,}140 \times 18.6}} = \frac{2{,}450}{1 + .346}$$

$$= 1{,}825 \text{ lb.-in.}$$

With the large lag angles involved, relief of bending because of blade flexibility is rather small for the plane of rotation.

In Table V, the resultant bending moments, corrected for blade flexibility, are calculated for normal flight (as would be used in a fatigue analysis of blade spar), assuming a spar of 1¾-in. o.d. by .095-in. gage, with $K = 2{,}140$ lb.-in. per deg. and using β_0, for 190 rpm., of 4.62 deg. These resultant bending moments, for normal flight, are plotted in Fig. 13. In Table VI, design bending moments (using limit load of 4.0, with factor of safety of 1.5 for those in plane of lift, and limit load of 1.5, with factor of safety of 1.5 for those in plane of rotation) are calculated, and shown graphically in Fig. 14.

Checking the structure of this helicopter blade with spar as previously assumed, first condition likely to be critical is that at first instant of starting. Here, one-third torque—corresponding to 191 hp. at 190 rpm.—is assumed to be absorbed by one blade and reacted by blade inertia, with design factor of 2.25. This is combined with blade flapping, with a design factor of 4.0. The section at .10R (end of sleeve connecting spar to rotor hub) will be assumed as critical for this condition.

Design starting torque per blade

$$= \frac{2.25 \times 5{,}260 \times 191}{190 \times 3}$$

$$= 3{,}965 \text{ lb.-ft.} = 47{,}500 \text{ lb.-in.}$$

At .10R, design starting torque

$$= 47{,}500 \times \frac{6{,}767}{6{,}940}$$ (ratio of blade moment outb'd. .10 R. to total blade moment)

$$= 46{,}400 \text{ lb.-in.}$$

Design flapping moment at .10R = 27,100 lb.-in. (calculation not shown.)

Resultant moment at .10R is:

$$M_{res.} = (27{,}100^2 + 46{,}400^2)^{1/2}$$

$$= 53{,}700 \text{ lb.-in.}$$

With section modulus $Z = .1939$ in.^{3},

$$f_b = \frac{53{,}700}{.1939} = 277{,}000 \text{ psi.}$$

$f_b/F_b = 277{,}000/179{,}500 = 1.543$

Blade root for above condition of stress would require a spar, at .10R, of some 55% greater strength than contemplated. This could be accomplished by using either a larger spar, step-tapering toward the blade tip, or a sleeve over the 1¾-in. o.d. by .095 spar adjacent the blade root. A 1⅞-in. o.d. by .058 sleeve, with $Z = .1459$ in.^{3}, would probably be satisfactory, giving combined $Z = .3398$ in.^{3}, and using D/T of the outer sleeve (32.4), the value of F_b is 161,000 psi. for U.T.S. = 150,000 psi.

With the 1⅞-in. by .058 sleeve,

$f_b = 53{,}700/.3398 = 158{,}700$ psi.

And $f_b/F_b = 158{,}700/161{,}000 = .986$—Satisfactory.

For the design flight condition at $\mu = .5$, Fig. 14 shows greatest absolute value of resultant design bending moment in blade to be − 8700 lb.-in. at .22R. With

Table VI — Calculation of Design Resultant Bending Moments in Helicopter Blade μ, .5; W, 2,100 lb.; Rotor Dia., 40.25 ft.; Rotor hp., 191; Rotor rotational speed, 190 rpm., 1¾-in. o.d. by .095 steel spar

	ψ = 90 deg.				ψ = 270 deg.			
% R	Limit load bending moment in plane of flapping, corrected for flexibility, lb.-in.	Limit load bending moment in plane of rotation, corrected for flexibility, lb.-in.	Resultant limit load bending moment, lb.-in.	Design resultant bending moment, lb.-in.	Limit load bending moment in plane of flapping, corrected for flexibility, lb.-in.	Limit load bending moment in plane of rotation, corrected for flexibility, lb.-in.	Resultant limit load bending moment, lb.-in.	Design resultant bending moment, lb.-in.
5	−3,460	354	−3,480	−5,220	1,105	626	1,270	1,905
15	−5,540	865	−5,605	−8,410	1,520	1,590	2,200	3,300
25	−5,600	1,180	−5,720	−8,570	1,590	2,130	2,660	3,990
35	−5,160	1,232	−5,305	−7,950	1,910	2,250	2,950	4,425
45	−4,290	1,317	−4,490	−6,730	2,045	2,420	3,010	4,515
55	−3,580	1,200	−3,780	−5,670	1,670	2,295	2,840	4,260
65	−2,740	982	−2,910	−4,360	993	1,945	2,180	3,270
75	−1,825	700	−1,955	−2,930	319	1,360	1,400	2,100
85	−960	332	−1,015	−1,520	−129	615	630	945
95	0	0	0	0	0	0	0	0

a blade weight outboard of $.22R$ of 45.6 lb., with C.G. at $.592R$, the centrifugal force, at 190 rotor rpm. is:

$C.F. = 19.9^2 \times 45.6/g \times 11.97 =$ 6,710 lb.,

with design C.F. = 6 × 6,710 = 40,260 lb.

Spar fiber stresses and stress ratios at .22R, with 1¾-in. by .095 steel spar, with U.T.S. = 150,000 psi., are:

$$f_c = \frac{40,260}{.4939} = 81,600 \text{ psi.}$$

$$f_b = \frac{8,700}{.1939} = 44,900 \text{ psi.}$$

$$\frac{f_c}{F_b} = \frac{81,600}{150,000} = .543$$

$$\frac{f_b}{F_b} = \frac{44,900}{179,500} = .250$$

Combined stress ratio = .793

Using data from Table V and Fig. 13, it is found that greatest variation of bending moment in plane of lift, between $\psi = 90$ and 270 deg., is at $.35R$. Using this point of blade radius, the different forces and moments acting on the spar will be analyzed from the standpoint of reversed bending (fatigue). (This example is conservative, in that reversed bending is considered at $\mu = .5$, (diving) rather than $\mu = .30$ (cruising)—the more normal practice for considering this type of stress.) With rotor rotational speed of 190 rpm., blade weight outboard $.35R$ of 37.8 lb., and C.G. of the outboard portion at 13.47 ft. from centerline of rotation, a steady centrifugal force is developed:

$C.F. = 19.9^2 \times 37.8/g \times 13.47 =$ 6,260 lb.

Bending moment in plane of lift, corrected for blade flexibility, is, for $\psi =$ 90 deg., − 3,720 lb.-in., and for $\psi =$ 270 deg., 1,263 lb.-in. Bending moments in plane of rotation are 982 and 1,775 lb.-in. With the bending moments in plane of rotation, of same sign, tending to bow blade backwards, it may be assumed there is an average moment of 1,379 lb.-in., with varying moment from this *average* of ± 397 lb.-in.

With 1¾-in. o.d. by .095 spar, and reducing $F_b = 179,500$ psi. to 150,000 × 1.197, where 1.197 is the form factor for a round tube of 18.4 D/T ratio, the following fiber stresses will be developed for the various load conditions:

$C.F. = 6,260/.4939 = 12,700$ psi. steady fiber stress.

In plane of flapping:

$$\psi = 90 \text{ deg.}, f_b = -\frac{3,720}{.1939 \times 1.197} = -16,000 \text{ psi.}$$

$$\psi = 270 \text{ deg.}, f_b = \frac{1,263}{.1939 \times 1.197} = 5,450 \text{ psi.}$$

In plane of rotation: Steady stress due to average bending moment of 1,379 lb.-in.:

$$f_b = \frac{1,379}{.1939 \times 1.197} = 5,950 \text{ psi.}$$

Stress due to varying moment of ± 397 lb.-in.:

$$f_b = \pm \frac{397}{.1939 \times 1.197} = \pm 1,710 \text{ psi.}$$

That is, f_b for $\psi = 90$ deg. = 4,240 psi., and for $\psi = 270$ deg. = 7,660 psi. in plane of rotation.

Considering upper and lower fibers of the spar in combination with forward fiber (that is, toward blade leading edge) and rear fiber, the following steady and varying stresses are obtained:

For $\psi = 90$ deg., stresses are:

Upper forward: $12,700 + (16,000^2 + 4,240^2)^{1/2} = 12,700 + 16,550$

Upper rear: $12,700 + (16,000^2 - 4,240^2)^{1/2} = 12,700 + 15,420$

Lower forward: $12,700 + (4,240^2 - 16,000^2)^{1/2} = 12,700 - 15,420$

Lower rear: $12,700 - (4,240^2 + 16,000^2)^{1/2} = 12,700 - 16,550$

For $\psi = 270$ deg., stresses are:

Upper forward: $12,700 + (7,660^2 - 5,450^2)^{1/2} = 12,700 + 5,390$

Upper rear: $12,700 - (7,660^2 + 5,450^2)^{1/2} = 12,700 - 9,400$

Lower forward: $12,700 + (7,660^2 + 5,450^2)^{1/2} = 12,700 + 9,400$

Lower rear: $12,700 + (5,450^2 - 7,660^2)^{1/2} = 12,700 - 5,390$

Most highly stressed fibers, from the standpoint of reversed bending, would appear to be either the upper rear or lower forward fibers. Using the Johnson-Goodman formula[8]:

$S_{max} = .5\ S_u/1 - .5r$, in which S_{max} = maximum allowable unit stress during a cycle, S_u = ultimate tensile strength (150,000 psi.) r = range ratio, the range ratio for the upper rear fiber is 12,700 (+ 15,420; − 9,400) = 28,120 to 3,300 psi., with $r = 3,300/28,120 = .117$, hence:

$$S_{max} = \frac{.5 \times 150,000}{1 - .5 \times .117} = 79,600 \text{ psi.}$$

With an allowable fiber stress of 79,600 psi., and a maximum stress of 28,120 psi. shown, margin of safety for upper rear fiber in reversed bending is:

$$\text{M.S.} = \frac{79,600}{28,120} - 1 = 1.83$$

The range ratio for the lower forward fiber is 12,700 (+ 9,400; − 15,420) = 22,100 to −2,720 psi. with $r = -2,720/22,100 = -.123$, hence:

$$S_{max} = \frac{.5 \times 150,000}{1 + .5 \times .123} = 70,500 \text{ psi.}$$

With an allowable fiber stress of 70,500 psi., and a maximum stress of 22,100 psi., margin of safety for the lower forward fiber is:

$$\text{M.S.} = \frac{70,500}{22,100} - 1 = 2.19$$

Upper rear fiber, with margin of safety of 1.83 is therefore critical, at $.35R$, in reversed bending for $\mu = .5$.

Designed to the above factors, and using methods substantially as outlined above, it is considered that a hub-driven helicopter blade will give satisfactory structural performance.

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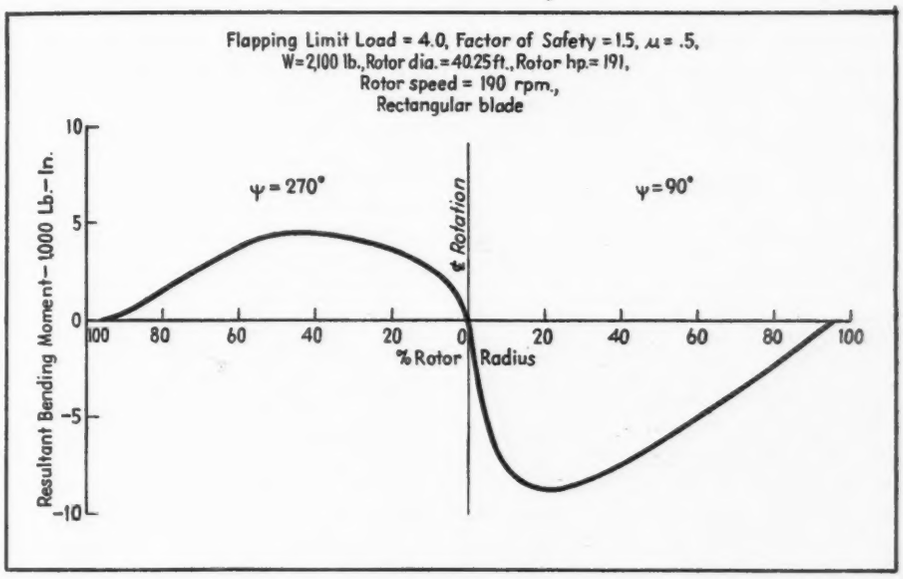


Fig. 14. Design bending moments in helicopter rotor blade.

POSITIVE ACTION LUBE SYSTEM PROVED FOR GOODYEAR F2G

By **V. S. Kupelian,** *Project Engineer, Goodyear Aircraft Corp.*

Outlined here are construction details and advantages of novel oiling installation specially developed to furnish uninterrupted flow during all flight maneuvers and attitudes.

NEED FOR a maneuver-type lubrication system is pointedly emphasized when you notice the oil pressure indicator dropping to zero after any flight configuration resulting in negative accelerations of the airplane. And oil pressure usually stays at zero until normal acceleration is resumed—obviously a very undesirable condition, for it not only starves the engine of a vital operating medium, but also results in poor operation of other power plant components dependent upon maintenance of engine oil pressure.

These factors were observed during early flight tests of the Goodyear F2G—a Navy fighter powered with a P&W R-4360 Wasp Major—and occurred to a marked degree because of increased oil flow attendant in this very large engine. The increased oil flow, coupled with a very short oil-in line from the tank, left very little reserve to be used if the main body of oil were removed from the tank outlet by negative accelerations during certain maneuvers. And it soon became apparent that a lubrication system was needed which would permit continuous oil flow during all maneuvers and attitudes of flight.

During the development of a satisfactory maneuver-type lubrication system for the F2G, many of the presently used schemes were considered, but found to be deficient. Some of the more common devices are reviewed here, along with their considered deficiencies:

The swinging-arm or pendulum type outlet, as used on some installations, was tested and discovered to stick occasionally because of sludge centrifuged out of the oil while going around the bend in the arm at the high speeds created by high oil flows encountered. Furthermore, this device was limited to rather deep tanks, precluding its use on shallow units which may be desirable for a more compact installation.

The sliding tube valve type of oil diverter was studied but was not considered sufficiently efficient, since it also involved the possibility of sticking as well as permitting continuous small air leakage if near-perfect fits were not attained.

Also studied was a system composed of a tank having dual outlets, with flapping valves on the main oil outlet and standpipe inlet, but this was found to be unsuited for pressurized tanks, and in addition, offered the possibility of continuous small air leakage through the standpipe.

Investigation of these, and several other types of oil diversion schemes for maneuver systems indicated one serious drawback to their fundamental method of operation—namely that of depending upon gravity to swing nozzles or lift valves or slide tubes *within* the oil tank. Hence, this was the only force available for positive opening and good seals. Furthermore, there always existed the possibility of failure because of sticking or air leakage created by foreign material in the tank or chemical residue in the oil.

Taking cognizance of these conditions, a maneuver-type lubrication system was developed for the F2G, as shown in Fig. 1, which was devoid of any moving parts

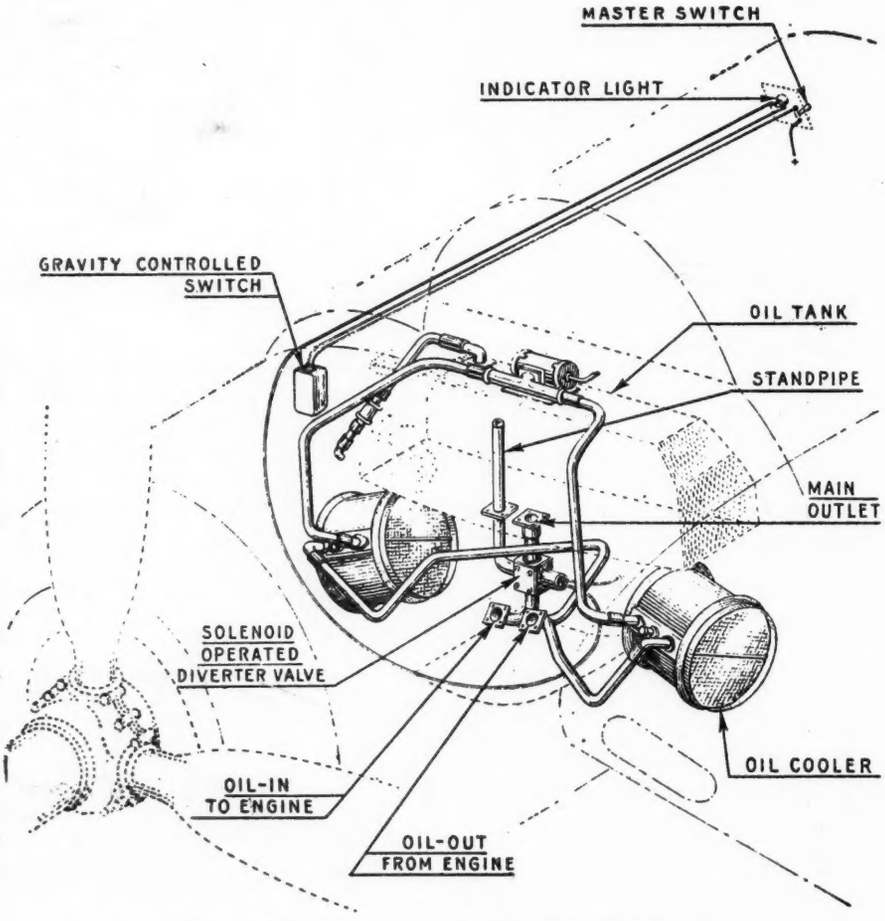


Fig. 1. Phantom view depicting installation details of maneuver-type lubrication system for Goodyear F2G.

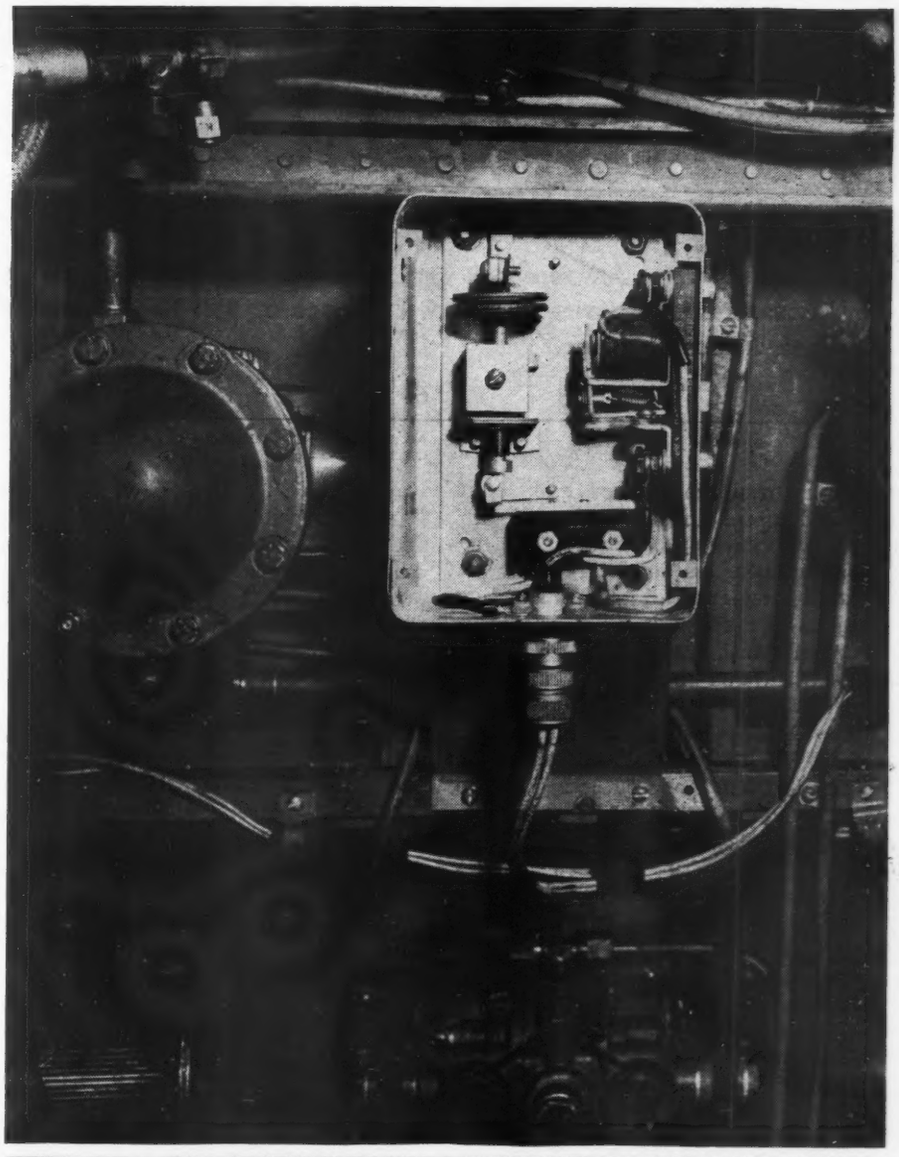


Fig. 2. Seen here is gravity energized switch for solenoid operated diverter valve.

within the tank, and could be associated with a tank of any size, shape, or location.

Basically, the system consists of a tank with a dual outlet, one of which is the main discharge in use during normal operation; the other is attached to a standpipe extending to a predetermined level within the tank. Externally, these two outlets are connected to a solenoid-operated diverter valve so that either line may be diverted to the engine, depending upon the position of the valve. Normally, the valve is positioned to the tank main outlet and positively maintained there by spring load. The maneuver- or standpipe-position is accomplished by a gravity operated electric switch which energizes the solenoid diverter valve. This arrangement is such that so long as there is an accelerating force tending to keep the oil away from the tank main outlet, this same force keeps the standpipe circuit open and the main outlet closed by means of the solenoid diverter valve with the gravity energized switch.

Perhaps the only difficulty in developing such a system was the construction of the gravity controlled switch which had to be sensitive enough to operate at fairly small deviations from normal acceleration, yet be sufficiently damped so that it would not be energized by disturbances of short duration—such as flying through rough air or in taxiing. The switch devised consisted merely of a sliding weight around a rod energizing a relay through a micro-switch, and a pair of small bellows attached to one end of the contacting rod to give the desired damping to the system, as shown in Fig. 2. The system also includes a light on the instrument panel for indicating the operation of the standpipe or maneuver circuit, also a manual main switch through which the entire system may be cut in or out.

A test installation of the solenoid operated diverter valve is shown in Fig. 3. A series of flight tests—encompassing entire range of engine speeds from idling to rated rpm. explored at accelerations of + .3 to −1.0 G—gave very satisfactory results.

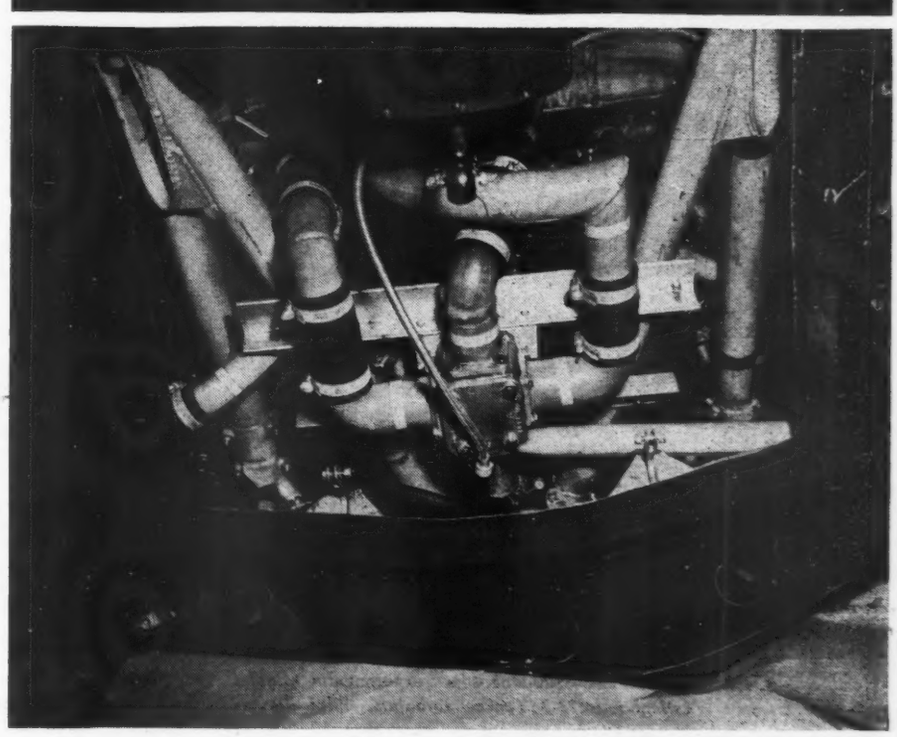


Fig. 3. Test installation of solenoid operated diverter valve.

Supersonic Plane and Jet Bombers Revealed by Army Air Forces

Spearheading drive for research funds and $600,000,000 engineering development center, Army discloses existence of Bell XS-1, designed to crack transonic range.

A PILOTED, ROCKET-POWERED craft designed to break through the transonic speed range; five jet propelled bombers; and three new jet fighters are revealed as outstanding projects of a research and development program which the Army Air Forces seeks to expand if sufficient funds are provided.

The AAF's first supersonic piloted aircraft, the Bell XS-1, has already been taken aloft and operated as a glider to test its flight characteristics. A myriad instruments have been designed to record essential data during the few minutes of powered flight. A newly developed pressure suit is provided for the pilot, since the plane may reach an altitude of 80,000 ft. If, as is possible, the craft becomes disabled going through the transonic range, the pilot is provided with an ejector seat. This unit is fired by a 37 mm. shell containing a special powder charge which accelerates seat and pilot to 40 mph. with a travel of 5 ft. After the plane has been cleared, another automatic charge releases shoulder and seat straps to free the pilot from the seat. An aneroid will automatically open the special ribbon parachute at a pre-set altitude.

The multi-jet bombers currently being developed are: North American XB-45, Consolidated Vultee XB-46, Boeing XB-47, Martin XB-48, and Northrop XB-49, the latter a jet-powered version of the XB-35 Flying Wing. No information as to performance or construction is yet releasable on any of these craft.

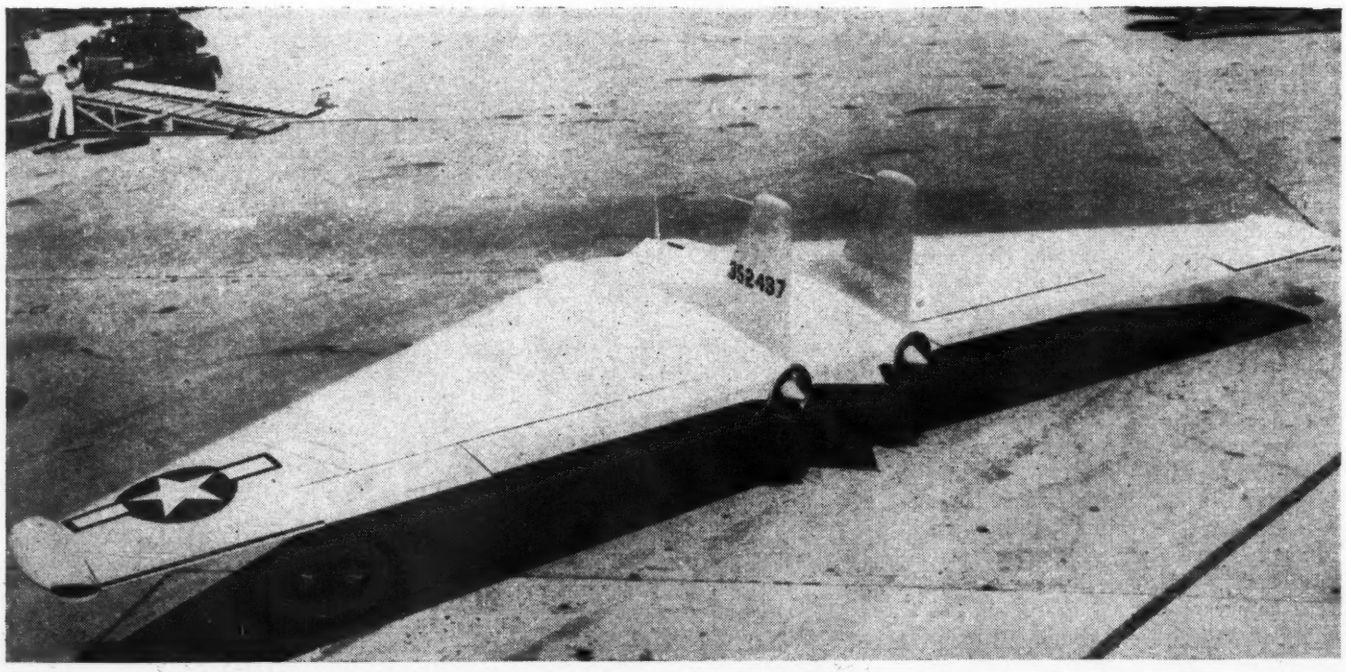
The jet fighters include the 500-mph.-plus Northrop XP-79B, powered by two Westinghouse 19-B Yankee axial flow turbojets. A flying wing of 38-ft. span, the craft's length is but 14 ft. The pilot flies from a prone position between the two power plants. The XP-79B is an all-magnesium craft, the Northrop heli-arc weld method having been used.

Single-engine jet fighters announced as under development are the North American XP-86 and the Curtiss-Wright XP-87, but no performance or structural data have yet been released.

Revelation of these jet propelled craft —together with glimpses of rocket, ram-jet, and other developments—are coupled with Army Air Forces pleas for funds for an expanded research and development program. As outlined before government agencies by Maj. Gen. Curtis E. LeMay, chief of the AAF Research & Development Agency, and to newsmen by Brig. Gen. Lawrence Craigie, chief of the Engineering Div., Air Materiel Command, Wright Field, this program would call for annual expenditures of $250,000,000 over a 5-yr. period.

Also sought is a proposed Aircraft Engineering Development Center, estimated to cost some $600,000,000, the facilities of which would be available to both military services and the aircraft industry, with administration in the hands of the AAF.

AAF plans for this center include five high speed wind tunnels—from 0.9 to 10M—with working areas of from 4–32



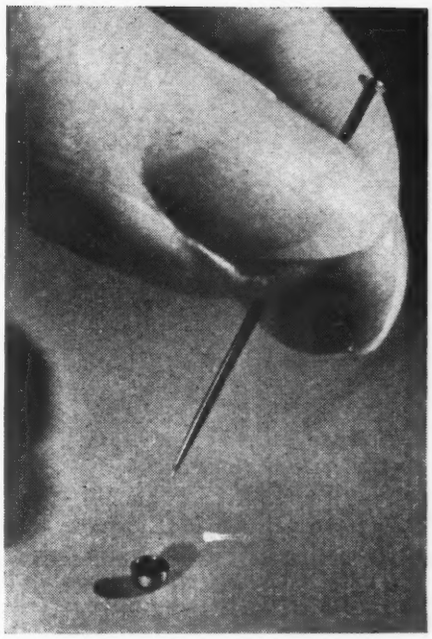
Northrop XP-79 Flying Ram, 500-mph.-plus experimental fighter powered by two Westinghouse 19-B Yankee turbojets. Pilot flies in prone position, which permits pull-outs up to more than 12 G's, as compared with 7 or 8 limit in conventional seats. Bellows rudder at wing tip permits passage of air during normal flight, but for turn pilot operates valve which diverts flow to bellows. (Press Assn. photo)

ft. Power requirements for such installations would run up to 1,400,00 hp. Although AAF officers have made no recommendations as to location, these power requirements would obviously necessitate locating the center near Government-owned hydroelectric plants of such capacity.

Large areas of land would also be necessary to properly test guided missiles, for the plan envisages rocket test stands of from 5,000–500,000-lb. capacity, with later units capable of testing rockets of 1,000,000 lb. thrust.

Under the plan, NACA would continue its function of providing basic research —particularly in aerodynamics and thermodynamics—to the extent of its facilities, with the military services working with industry on application of this research, and the services doing the major portion of the evaluation.

Industrial research would also be used under contract as it has in the past, AAF officers point out. Typical of such research is that done by the ball and roller bearing industry which, largely as a result of independent metallurgical work, today has bearings capable of operating over a temperature range of from —74 to +1,725 deg. F., with an upper limit of 2,500 deg. now held capable of attainment. Operating in turbojets capable of giving plane speeds of 600 mph., bearings turn at 72,000 rpm. and withstand immediate shock loads of 168,000 lb. per sq. in.



Independent research by bearing industry goes beyond development of such items as this "smallest mass-produced ball bearing", measuring but 2.7 mm. in dia. and containing three 1-mm. balls complete with separator. Research on such projects has brought metals with —.74 to + 1,725 deg. F. range, with upper limits soon to go higher.

Whether or not the nation's military research and development program takes the form advocated by the AAF, the need for a continued, coordinated plan was emphasized at the AAF's National News Conference by Dr. Vannevar Bush, director of Office of Scientific Research & Development, who declared that "I believe thoroughly that we do not need to regard a major war as inevitable . . . [but] it seems to me crystal clear that there is no hope whatever of a satisfactory outcome unless this country fully preserves its strength in every way in the difficult period that lies immediately ahead, for it is only in our full strength that we can work for ultimate peace."

Pointing to the lessons learned during the war, Dr. Bush said "it is utterly essential that we should have a unitary national program of military research, thoroughly integrated and correlated, with unwise duplication eliminated," adding that "correlation should in no sense involve suppression of valuable effort. It must preserve the vigor and resourcefulness of highly autonomous groups pursuing actively the ideas which they believe to be most important. Moreover, correlation does not mean the removal of beneficial competition. It is a good thing for this country that we should have vigorous groups pursuing their several parts somewhat along parallel lines at times, and with emulation and strong competition to keep them on their toes."

New Records Established by Army Air Forces

Category	Speed	Plane	Pilot	Prev. Record	Plane	Pilot
100 km. (62 mi.) without payload	495	Lockheed P–80	Capt. Robt. A. Baird III	394	Heinkel	Ernst Udet (Germany)
1000 km. (621.3 mi.) without payload	462	Lockheed P–80	Lt. Henry Johnson	325.7	Breda 88	Furio Niclet (Italy)
2000 km. (1242.9 mi.) without payload	462	Lockheed P–80	Lt. Henry Johnson	325.7	Breda 88	Furio Niclet (Italy)
1000 km. with 1,000 kg. payload	369	Boeing B–29	Lt. E. M. Grabowski	325.7	Breda 88	Furio Niclet (Italy)
2,000 km. with 1,000 kg. payload	366	Boeing B–29	Lt. E. M. Grabowski	311.1	Junkers Ju–88	Ernst Seibert (Germany)
2,000 km. with 2,000 kg. payload	366	Boeing B–29	Lt. E. M. Grabowski	311.1	Junkers Ju–88	Ernst Seibert (Germany)
2,000 km. with 5,000 kg. payload	366	Boeing B–29	Lt. E. M. Grabowski	250.9	P–23	A. Tondi-G. Pontonutti (Italy)
1,000 km. with 5,000 kg. payload	369	Boeing B–29	Lt. E. M. Grabowski	259.3	Boeing YB–17	C. S. Irvine-P. H. Robey (U. S.)
1,000 km. with 2,000 kg. payload	369	Boeing B–29	Lt. E. M. Grabowski	321.2	Junkers Ju–88	Ernst Seibert (Germany)
1,000 km. with 10,000 kg. payload	358	Boeing B–29	Capt. J. D. Bartlett	207	Savoia-Marchetti SM–75	N. Prota-G. Bertocca (Italy)
2,000 km. with 10,000 kg. payload	356	Boeing B–29	Capt. J. D. Bartlett	205	Savoia-Marchetti SM–75	N. Prota-G. Bertocca (Italy)
Helicopter duration— 9hr. 33 min. 27 sec.		Sikorsky R–5	Lt. Wm. L. Vavricka-Lt. K. R. Bloom	1:32	VS–300	Igor Sikorsky (U. S.)
Helicopter distance		Sikorsky R–5	Maj. F. T. Cashman (Dayton-Boston)			
Helicopter 20 km.	110.5	Sikorsky R–5	Lt. Col. K. S. Wilson	76.1	Focke-Wulf 61	Ewald Rolfs (Germany)

BRITISH AIRLINER PRESSURIZATION INITIATED ON TUDOR I

Here are details of this new airliner's high-flight cabin-conditioning apparatus comprising a combined heating and ventilation system. Also revealed are a few of the tests on leakage and strength characteristics of craft's cabin design.

PRESSURIZATION EQUIPMENT fitted to the Avro Tudor I is said to mark Britain's first venture in maintaining low-altitude atmospheric conditions in an airliner. This 12-24 passenger transport plane is now in quantity production for BOAC and, credited with a 345-mph. top speed, it is slated for high-speed North Atlantic operations. (Also see page 177 Aug. 1945 AVIATION).

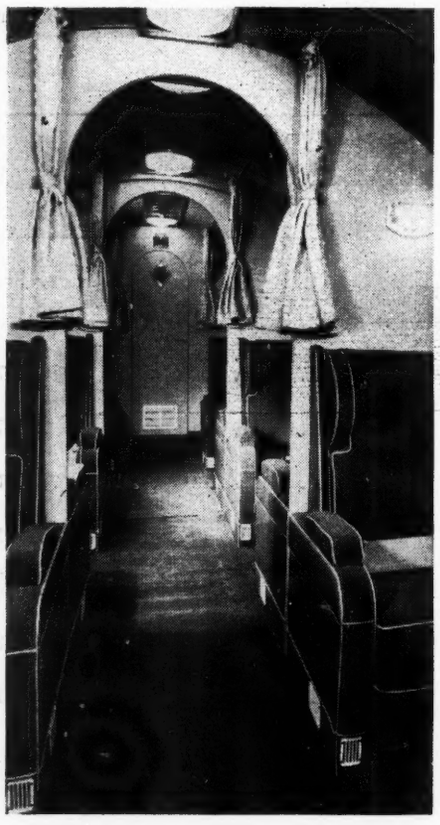
Except for a small portion of the fuselage rear, the whole of the Tudor's cabin volume, above and below floor level, is pressurized to maintain atmospheric conditions common at 8,000 ft. while the plane is flying at 25,000 ft. A large number of flight tests have been conducted, including two at over 29,000 ft.

Intake and Ducting System

Heating and ventilation are combined in Avro's pressurization system. Atmospheric air enters a combined scoop and inertia filter located under each outer wing's leading edge at a point between ribs 13 and 13A, at which position the intakes are said to be away from the prop wash and out of the area contaminated by engine exhaust gases.

The air is then ducted to Marshall No. 15 blowers, mounted one to each outboard Merlin engine's accessory gearbox, and it is then passed through a silencer fitted between outer wing ribs 5 and 6, an air cooler set between outer wing ribs 3 and 4, and then to a second silencer between the inboard engine and the fuselage.

This air then enters the fuselage ducting through a spill valve which incorporates a no-return valve (to assure that pressure will not be lost if one blower should fail), and is taken through a re-circulating fan chamber, heated by a Janitrol unit of 50,000 Btu./hr. capacity, and is next delivered to the main distribution ducting which runs below the floor the length of the plane. Manifolds are welded to form part of this ducting and terminate with mushroom-headed outlets in the crew stations and toilets. The passenger cabin supply is sent through the tubular arms of the chairs.



Passenger comfort appears to be well provided for in Tudor I, with cabin compartmented and sets of facing chairs. Heating and ventilating grilles may be noted at base of chairs near aisles. Exhaust air is extracted via slots cut around periphery of ceiling light reflectors.

Some cabin air is taken through the re-circulating fan chamber and mixed with the incoming cold air for re-heating and re-distribution. A discharge valve near the rear of the cabin is combined with a safety valve, and a differential pressure of 5.5 lb./sq.in. is maintained in the cabin at altitude. Two aneroids in the flight engineer's compartment are connected with the exhaust valve and regulate the amount of air passing out. The master control valve is on the engineer's panel, and a combined ground conditioning and inward relief valve is fitted in the bottom fuselage skin at the aft end of the cabin, on the airplane's center line.

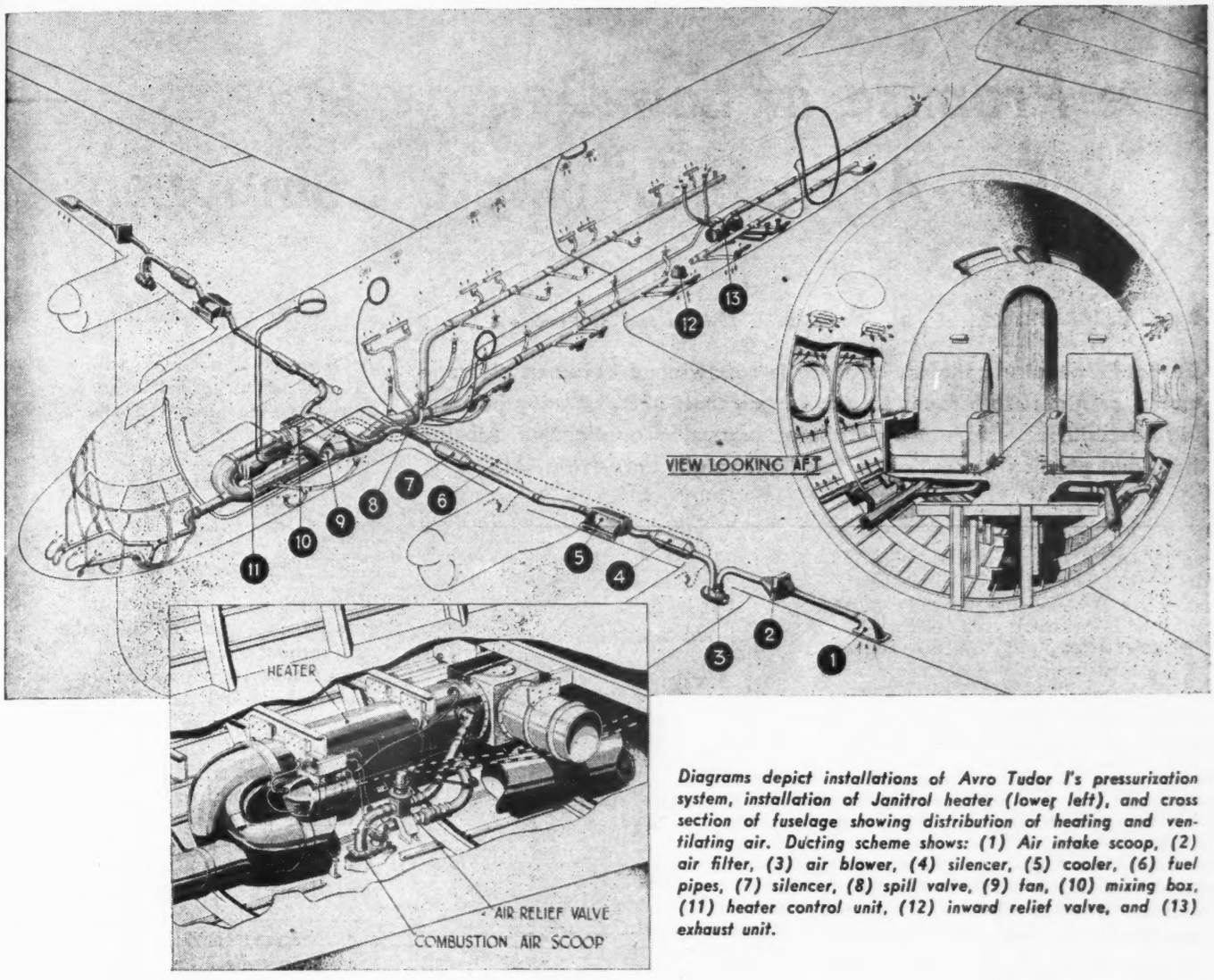
Heating arrangements have been designed to cover the wide range of temperatures expected to be encountered in various parts of the world throughout the year. A controllable cooler, fitted in the ducting which carries the air from compressor to cabin, enables the flight engineer to utilize or dissipate the heat which is generated by compression of air in the blowers.

Cabin Sealing

All riveted and other metal-to-metal joints are sealed with a compound during assembly. All control rods and control cables pass through pressure seals where they emerge from the fuselage interior. And the astrodome, jettisonable cabin windows, and entrance door are sealed by inflatable rubber inserts. The nose cap is sealed with a solid rubber insert.

Pressurization Testing

An extensive preliminary investigation covering leakage and strength considerations was carried out on small portions and full scale structures before a major test was initiated on a full scale fuselage.



Diagrams depict installations of Avro Tudor I's pressurization system, installation of Janitrol heater (lower left), and cross section of fuselage showing distribution of heating and ventilating air. Ducting scheme shows: (1) Air intake scoop, (2) air filter, (3) air blower, (4) silencer, (5) cooler, (6) fuel pipes, (7) silencer, (8) spill valve, (9) fan, (10) mixing box, (11) heater control unit, (12) inward relief valve, and (13) exhaust unit.

During intitial tests, the total mass leakage of the test fuselage was found to be excessive, being 16.1 lb./min. at a pressure differential of 2¾ lb./sq. in., and representing 53.6% of the available compressor supply of 30 lb./min. Major leakages at a number of points were reduced until finally total mass leakage was 2 lb./min. at 5½ lb./sq. in. pressure differential. This specimen was considered satisfactorily sealed.

Plasticene, sealing tape, and sealing compounds were all tried, and it was noted that: (1) It was not necessary to seal bucked heads of rivets, even where there were structural connections; (2) sealing of structural joints with tape overlay was unsatisfactory; and (3) sealing of structural joints by internal application of a suitable sealing compound by spray or brush was considered an ideal method.

Strength tests had as their secondary objectives the verification of design stress assumptions and also determination of stresses at points where calculations were difficult or unreliable. For proof pressure, the A.R.B. requirements (sub-section D.22, paragraph 3) quote a factor of 1.33 on maximum flight pressure differential. At 5½ lb./sq. in. unit pressure differential, proof pressure equals 7.33 lb./sq. in. For ultimate pressure, A.P. 970 requirements (Chap. 718, paragraph 5) quote ultimate factor of 2 on the maximum flight pressure differential. At 5½ lb./sq. in. unit pressure differential, ultimate pressure equals 11 lb./sq. in.

Tests showed that the structure is satisfactory for strength at proof and ultimate pressures, that much useful information regarding the diffusion of load in the region of fuselage openings is provided by the extensive use of strain gages, and that at no point in the structure were stresses in excess of 11 tons/sq. in. recorded up to the maximum factored pressure differential of 11 lb./sq. in.

In a 20-min. strength test, during which the specimen was given pressure up to 11 lb./sq. in., no structural failure or detrimental distortion of the test specimen was observed with the exception that bearing failure occurred at the blind holes in the entrance door magnesium alloy frame casting, which receives the steel locking pegs. It was noted that the whole air thrust on the door was transmitted as shear to these pegs, which in turn exerted considerable local bearing loads on the door frame casting.

During a later test where pressures of 11 lb./sq. in. were recorded, the right Triplex windshield shattered completely on the outer lamination, but it still held pressure. As pressure was allowed to drop, the left windshield shattered in a similar manner. Since then, a modified windshield is stated to have been tested satisfactorily, and this is now being installed on production models of the Tudor I.

See Promise in Low-Density Core For Aircraft Laminate Components

By **R. E. MAIER**, *Chemicals Div., Plastics Dept., E. I. du Pont de Nemours & Co.*

Du Pont's cellular cellulose acetate is sandwiched between plywood, metal, or glass-cloth faces to provide aircraft units offering interesting possibilities. Here are details of suggested application, fabrication, and physical proerties of this lightweight core material.

DEVELOPED PRIMARILY for use as a structural core material between strong surface skins in low-density sandwich-type structures, du Pont CCA—cellulose acetate in an unoriented multicellular form—possesses a high degree of uniformity and excellent strength, suggesting its utilization in numerous aircraft applications.

Since the strength required in a structural core depends both on service requirements and properties of the surface skin materials, a core material furnished in only one density or strength would find rather limited use. Consequently, CCA is fabricated in various densities between 4 and 8 lb./cu. ft.—each within a range of ± 0.5 lb.

The product is available in form of extruded boards, with length limited only by size of container and method of shipment. Width and thickness of the slab are limited by the nature of the process and capacity of present manufacturing equipment. A semi-commercial unit is now producing material of widths between 4 and 6 in. and of thicknesses between ½ and 1 in. Slabs, sheets, and blocks such as those shown in Fig. 1 can be built up very readily from these boards by various methods of gluing.

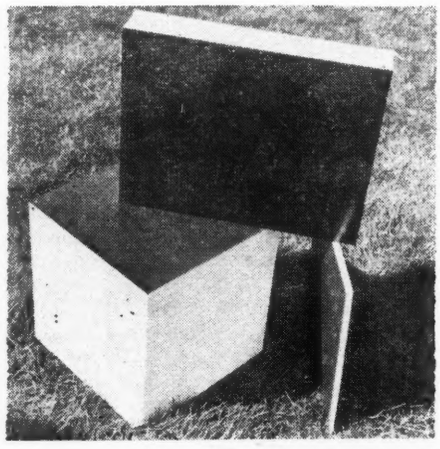


Fig. 1. Seen here in various thicknesses, du Pont CCA—cellular cellulose acetate—indicates possibilities of this material for core use between plywood faces. (Articles, shown in photos, furnished by Skydyne, Inc.)

Applications Specified

Du Pont CCA was first used as a core material in secondary and non-structural aircraft applications because of its uniformity, strength, and low density. Use of this material in primary structures, such as a wing or fuselage is now being investigated by manufacturers.

Flat thin laminates of CCA with plywood, glass-cloth, or metal are being tested for use in aircraft floor panels, bulkheads, furnishings, and doors. Low-density CCA—4–5 lb./cu. ft.—has sufficient strength for most of these uses.

An electrical instrument case of CCA and aluminum embodies favorable electrical properties of the acetate as well as this material's low density and good strength. Uniformly curved sections, such as the cylinder shown in Fig. 2 are proposed for use as aircaft heating ducts and helicopter tailcones. The use of CCA laminates in food storage cases for commercial passenger planes has been proposed because the material also

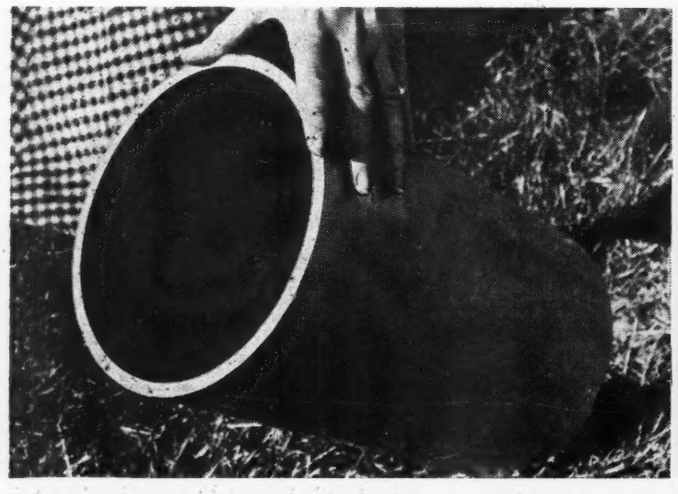


Fig. 2. This prototype section of heating duct has been formed with CCA as core material faced with aluminum. Similar section has possibilities for use as 'copter tailcone.

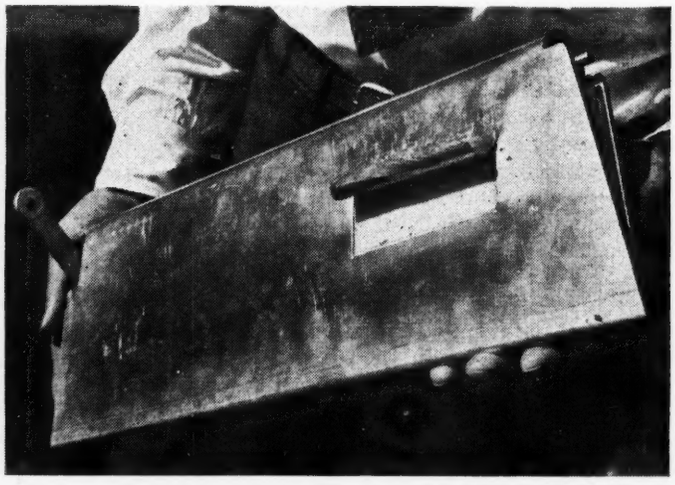


Fig. 3. Aileron tab with portion of aluminum skin turned up, reveals CCA core. This lightweight material is easily curved at leading edge radius and affords support for thin aluminum faces.

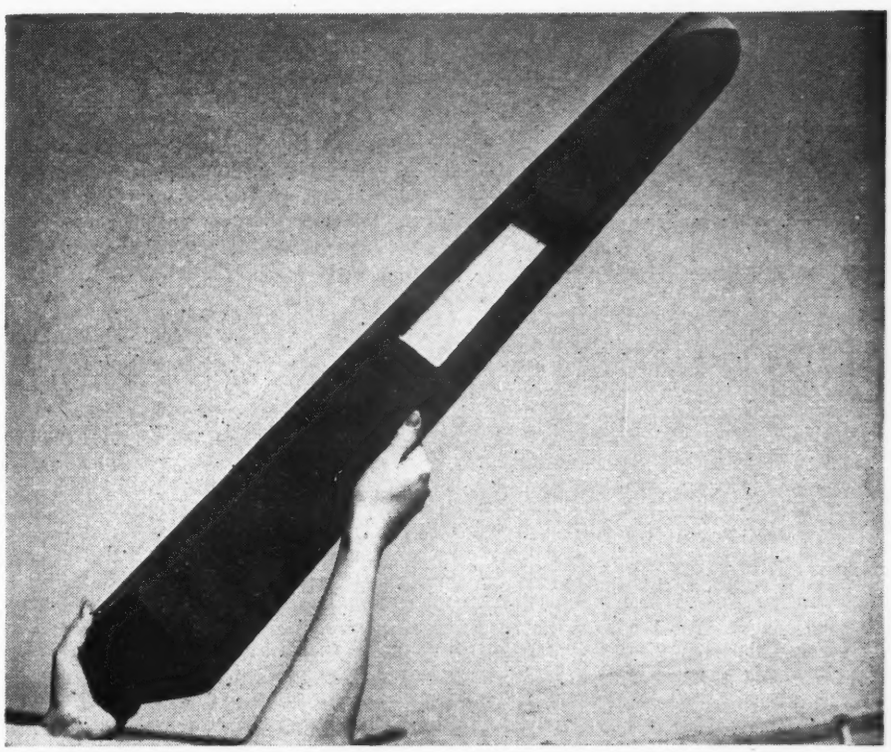


Fig. 4. Indicated here is application of CCA as core material for plywood- or metal-faced helicopter anti-torque rotor blade. In this installation, purpose of CCA core is to afford high rigidity with little increase in weight.

has relatively good thermal insulating properties.

Laminated control sections—fins, rudders, trim tabs, and ailerons—are light, strong, and, because of the absence of internal bracing, are simpler in design than conventional metal structures. A typical monocoque-type trim tab is shown in Fig. 3. The laminated helicopter anti-torque blade shown in Fig. 4 is an example of a use that requires relatively high strength in the core.

Machined pieces of any desired shape can be made from slabs of CCA by use of standard woodworking equipment. If a gang router is used to cut a series of parallel wedge-shaped grooves three-quarters through the material, the core can be shaped without heating by bending it so that the cuts are on the inside of the curve. If the kerfs are properly spaced and coated with glue, they will close and weld together during the final laminating operation to give a strong reinforced structure. If the material is carefully heated to a temperature just below the softening point (400 deg. F.), it can be shaped without grooving.

If a piece of cellular cellulose acetate is squeezed in a cold die, it will permanently assume the shape of the die. Since dies of wood or soft metal can be used in this cold hobbing operation, the technique provides a simple means of producing complicated shapes with simple equipment.

Standard thermosetting glues are satisfactory for bonding CCA to itself or to surface skins. If a dielectric heating unit is used to heat the glue, gluing time can be reduced to 15 sec. The high softening temperature, resulting from absence of plasticizing ingredients, permits use of thermosetting resin adhesives in the fabrication of laminates.

Low-Density Laminate Properties

Tests conducted by various investigators indicate that a well-designed flat laminate, when subjected to an edgewise compressive force, will withstand a load equal to 50-75% of ultimate strength of surface skins. Reported are buckling skin stresses of the order of 10,000-14,000 psi.[1] for papreg-CCA laminates and 20,000-28,000 psi.[2] for glass fiber-CCA laminates. The following tabulation summarizes several of the properties of a low-density laminate[2] with 7-lb./cu. ft. CCA core and glass cloth skins, made at Wright Field.

Edgewise comp. strength lb. per in./wt. per sq. ft.	1,075
Ult. bending strength lb. ult./wt. per sq. ft.	575
Bending stiffness *EI*/10	725

Properties of CCA in the various densities are summarized in the appended table. The high shear strength is a definite advantage and the impact strength is relatively high for a material of such low density. CCA will support combustion in still air, but the flame is readily extinguished by slowly moving air.

References

1. "Buckling of Sandwich Type Panels," by N. J. Hoff and S. E. Mautner, published by *Institute of Aeronautical Sciences.*
2. "Core Materials for Sandwich Structures," by Capt. G. B. Rheinfrank, Jr., and Capt. W. A. Norman, *Modern Plastics,* July 1945, pp. 127-131.

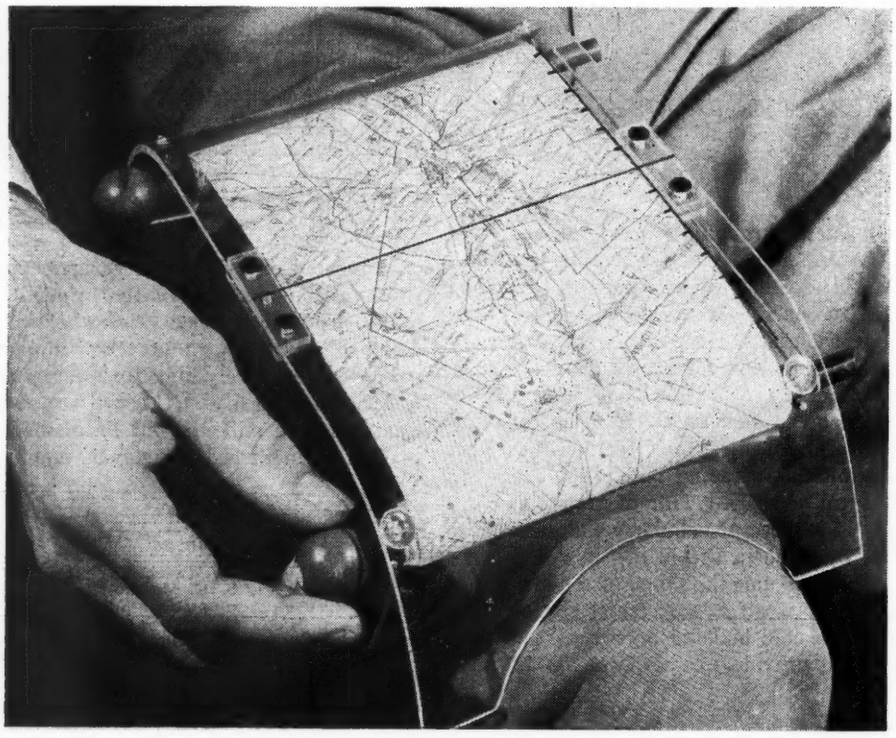
Properties of du Pont CCA

Property	Test Procedure*	4 to 5 lb./ft.³	6 to 7 lb./ft.³	7 to 8 lb./ft.³
Ult. tensile strength at 77 deg. F., psi.	(1)	95±15	175±25	235±25
Ult. tensile strength at 170 deg. F., psi.	(1)	95±15	125±25	175±25
Ult. compressive strength, psi.	ASTM D695-42T	75±15	125±25	175±25
Comp. strength at 2% deformation, psi.	ASTM D695-42T	70±15	100±25	125±25
Modulus in compression, psi.	from compressive data	3,500±750	5,500±1,000	6,700±1,200
Shear strength in tension, psi.	(2)	125±15	140±25	185±25
Shear strength in compression, psi.	(3)	85±15	125±25	200±25
Impact strength, ft.-lb./in.	(4)	0.04	0.1	0.15
Thermal expansion, in./in./1 deg. F.	(5)	....	2.5×10^{-5}	2.5×10^{-5}
Moisture content at 50% R. H., lb./cu. ft.	(6)	0.1-0.2	0.1-0.2	0.1-0.2
Moisture content at 100% R. H., lb./cu. ft.	(7)	0.5-0.7	1.0-1.1	1.0-1.1
Buoyancy after 24 hr. submersion in water, lb./cu. ft.	(8)	53.5	52.5	51.5
Thermal conductivity, Btu./ft.²/hr./deg. F./in.	....	0.3	0.31	0.32

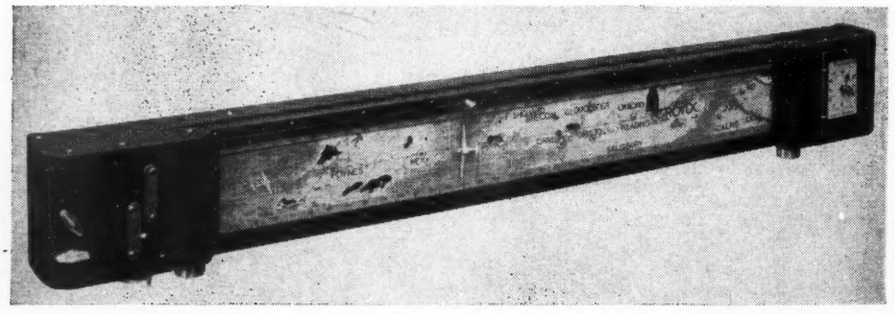
* All tests run at 77 deg. F. and 50% R. H., except as otherwise specified.
(1) Samples ¾ × 1 × ½ in. glued to maple blocks. Tested at 0.2 in. per min. loading speed. Load applied parallel to direction of thickness.
(2) Piece 1 × 1 × ½ in. glued to ½-in. birch plywood. Load in tension applied perpendicular to ½-in. dimension at a rate of 0.2 in. per min.
(3) Two specimens ½ × 1 × 1 in. glued to 3 maple blocks. Tested with Johnson jig.
(4) Unnotched specimens ½ × ½ × 2½ in. Izod impact.
(5) Direct measurement within the range of 77 and 170 deg. F.
(6) Gain in weight from 0 50% R. H.
(7) Gain in weight from 0-100% R. H.
(8) Direct measurement.

Roller-Mounted Maps Expedite Position Finding

American development for personal pilots is a simplified chart holder which is seen speeding up position and mileage plotting; while more complex British instrument is self-contained unit to aid airliner passengers in following plane's flight.



Walters' avigation aid is shaped to provide convenient usage of aero maps by personal flyers. Necessary chart is attached to rollers at either end of holder and can be turned to desired position by means of knobs. At left side is mileage scale inscribed in transparent face, while across center is marked a position-indicator line.



Utilizing no external mechanisms or connections, Comdr. Hole's air position indicator is designed to show air passengers location of their plane, proximity to next stop, and estimated time of arrival. Photo shows map in place and small airplane model near center.

TWO NEW AIR POSITION devices utilizing rolled charts have been developed—one by an American inventor, intended to make personal-flying avigation easier; and the other, made in Britain, designed to give airliner passengers constant visual evidence of their plane's location.

The private flyer's avigational aid, devised by Frank J. Walters of Washington, D. C., is a compact chart holder consisting of a Plexiglas frame so devised that it fits the upper contour of the pilot's leg. At each end of the transparent face is positioned a roller to which a standard aero chart may be attached. A mileage scale and a central position indicator are inscribed on the transparency's upper face.

Once the chart has been folded to cover the proposed flight route, it can be attached to the rollers by means of clips, thus providing a convenient holder, obviating frequent chart unfolding, folding, and haphazard estimating of mileage and position data.

Briton's Air Position Indicator

Designed by Wing Comdr. C. Hole, is indicator instrument now being manufactured by Redwing, Ltd., of London. This device, stated to be entirely self-contained, has no external wiring. There are two models, one 5 ft. long, 6 in. deep, and 3 in. wide; the other 3 ft. long, 6 in. deep, and 3 in. wide. The larger version weighs about 15 lb.

The instrument contains a strip map revealing about 600 mi. at a time, and over this map travels a model airplane, which can be synchronized with the airliner's speed within a 100-to-400-mph. range. Maps are stowed on two spools and may cover up to 8,000 mi. on a 1/20th scale. A clock is installed giving estimated time of arrival, and maps are marked with plus or minus time variations, relating to standard time or time of the country of departure.

Thus, with the indicator installed in the cabin in full view, passengers are able to keep informed, up-to-the minute, as to where the airplane is, a particular advantage if the craft is flying above overcast.

The device has been given the name "FRED", connoting Flight Route Easily Determined.

AIRCRAFT ACOUSTICAL PROBLEMS AND POSSIBLE SOLUTIONS

PART 1*

By K. R. JACKMAN, *Chief Test Engineer, Consolidated Vultee Aircraft Corp., San Diego.*

Here is a new approach to the age-old noise bugaboo, an approach which brings new tools for increasing passenger comfort and aircraft utility in the transport, military, and personal plane fields.

THE TITLE FOR THIS SERIES has been chosen advisedly, for in a field as new as aircraft acoustics there are many more problems than answers, and here solutions are not promised, but suggested as possibilities. The conclusions and comparisons drawn are based on intensive acoustical effort by several test engineers at Consolidated Vultee Aircraft Corp., San Diego, Calif. Further effort by noise-conscious aircraft manufacturers and airline operations may result in some definite solutions and consequently in quiet, lightweight planes.

But where should the start be made in this broad field of aircraft acoustics? There is the field of everyday sounds of which each person is altogether too conscious, and of which the National Noise Abatement Council is constantly reminding us. There is also the medico-otological (ear specialist) field of the

* From paper presented before Los Angeles Aviation Section and Semi-Annual Convention, ASME, Detroit.

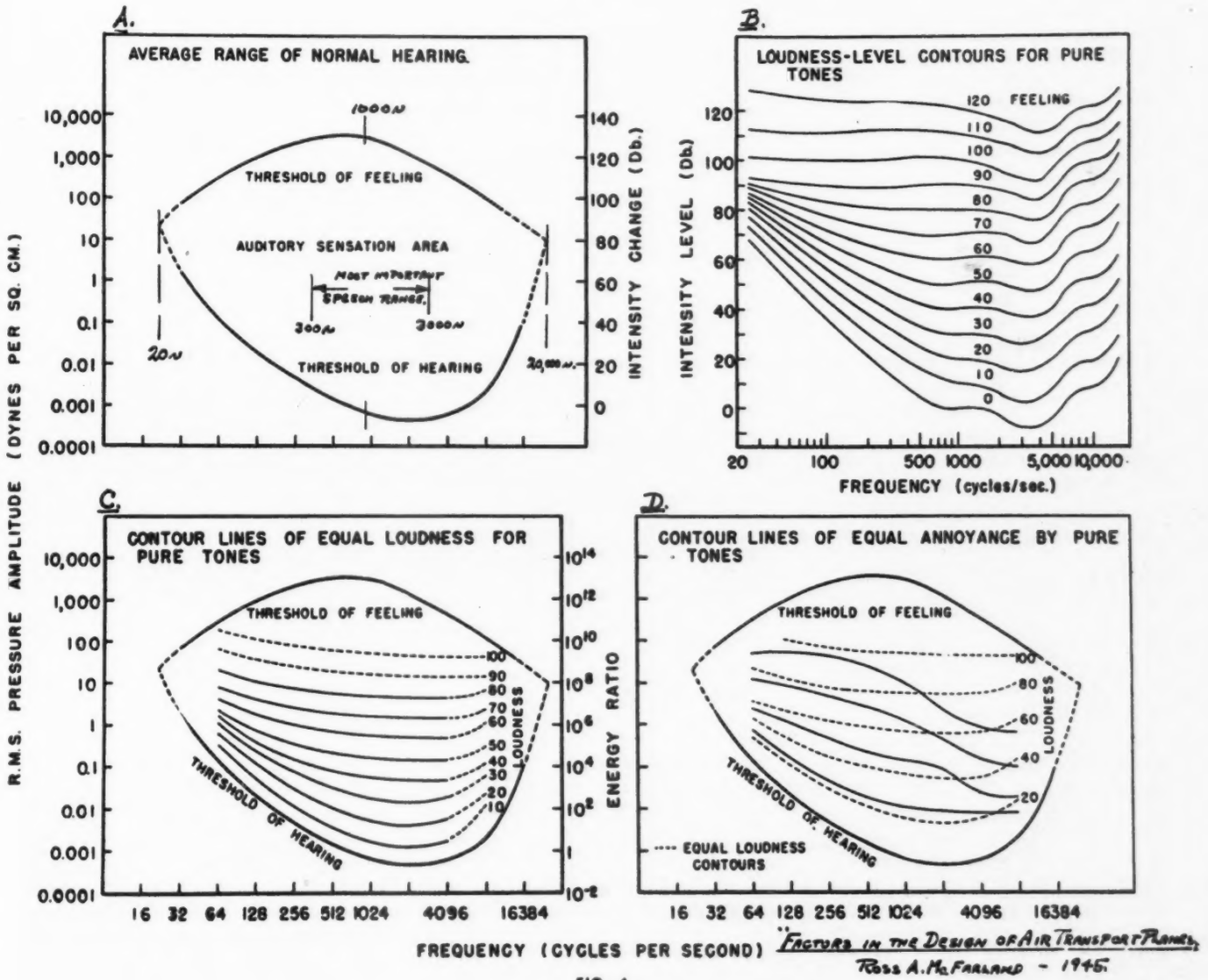


FIG. 1

FIG. 2

effect of noise on the human ear and organism. An outgrowth of this problem is the determination of auditory "annoyance", "fatigue", and permanent injury under high-intensity noises of modern industry and transportation.

Finally we come to the comfortization of modern aircraft cabins, with the recently increased emphasis by the airlines on reduction of noise and vibration, but "at no expense in weight". On each of these phases of the problem we could profitably write a book but with only a few pages available, the most fruitful discussion may be in the consideration of practical applications of such empirical acoustical data now at our disposal to soundproof today's planes.

To the layman or engineer not conversant with acoustics, the decibel may be a stumbling block. Many readers, of course, realize that it is a ratio of two sound intensities or pressures; the measured noise level to that of the chosen base. In other words, a decibel equals $10 \log 10 \frac{I}{10}$ or $20 \log 10 \frac{P}{P_0}$. where I equals the sound intensity and P equals the effective sound pressure, with zero subscript denoting base levels.

In more practical form the decibel may be considered, as shown on Fig. 1A, as approximately 1/30th of the intensity level between the thresholds of hearing and feeling and has been described as the smallest change which the average ear can detect.

Several bases have been used in the last 20 yr. in specifying aircraft noise levels but through the efforts of the Acoustical Society of America and the American Standards Association the threshold of hearing or zero decibels (db) reference level is now taken at 0.0002 dynes or 10^{-16} watts per sq. cm., or 0.207 millibars of pressure at 1,000 cps. frequency. This reference base is approximately 14 db above the levels used by such investigators as Zand, Frische, and other Sperry engineers.

The decibel has several other characteristics often slighted by engineers. Being a logarithmic function, the doubling of the noise intensity results in a 3 db rise. Conversely, if an aircraft engine produces 110 db of noise equally divided between its propeller exhaust components, complete elimination of the exhaust noise by a theoretically perfect muffler would reduce the overall noise level in the engine field to only 107 db. In a similar manner three times the noise intensity will add 4.8 db, four times 6.0 db, and ten times 10 db. The manufacturers of soundproofing materials talk quite glibly of the 20 or 30 db attenuation or noise reduction of their products in the 5000 cycle per second frequency region. Such a reduction, however, takes on more meaning when it is recalled that the sound energy remaining is thus only 1% or 0.1% respectively of its original intensity prior to soundproofing.

This slow decrease of overall noise levels is discouraging until it is learned that passenger cabin comfort is not a function of overall noise levels alone, but of the intensities of specific frequencies. Before this series is completed, it is the writer's intention to show that the overall noise level is a false measure of soundproofing and comfort and in its place should be substituted the octave band frequency method of designating the integrated noise intensities at several points of the auditory spectrum; possibly at the 75–150 cps. low frequency and at the 1,200–2,400 cps. speech frequency.

Fig. 1B indicates the normal ear is much more responsive to sounds between 2,000 and 4,000 cps. and progressively insensitive at higher and lower frequencies. These are the familiar Fletcher-Munson curves widely circulated in the ASA Bulletin. Dr. Leo Beranek of Harvard says that "experimental data show that the components of speech at the very low and very high frequencies contribute almost nothing to the intelligibility of spoken words, while those components whose frequencies lie between 840 and 2,800 cps. contribute, in quiet locations, as much to speech intelligibility as do all components above and below."

The remainder of the human audible spectrum from 20 to 20,000 cps. aids in the complete enjoyment of music. Fig. 1C shows the contour lines of equal loudness for pure tones and Fig. 1D the contour lines of equal annoyance by pure tones. It appears desirable to decrease noise in the important speech range of approximately 1,000 to 3,000 cycles to prevent annoyance and auditory fatigue. Thus the octave band of 1,200–2,400 cps. may form a logical criterion for ease of speech reception.

Few of us would expect to read a magazine comfortably and in extreme quiet in a room adjacent to a railroad track and separated therefrom by a wall composed of .030-in. aluminum sheeting and some fluff on rather flimsy uprights. A locomotive, generating 2,200 hp. or the equivalent of many of our modern aircraft engines, thundering past that wall might well cause the reader some

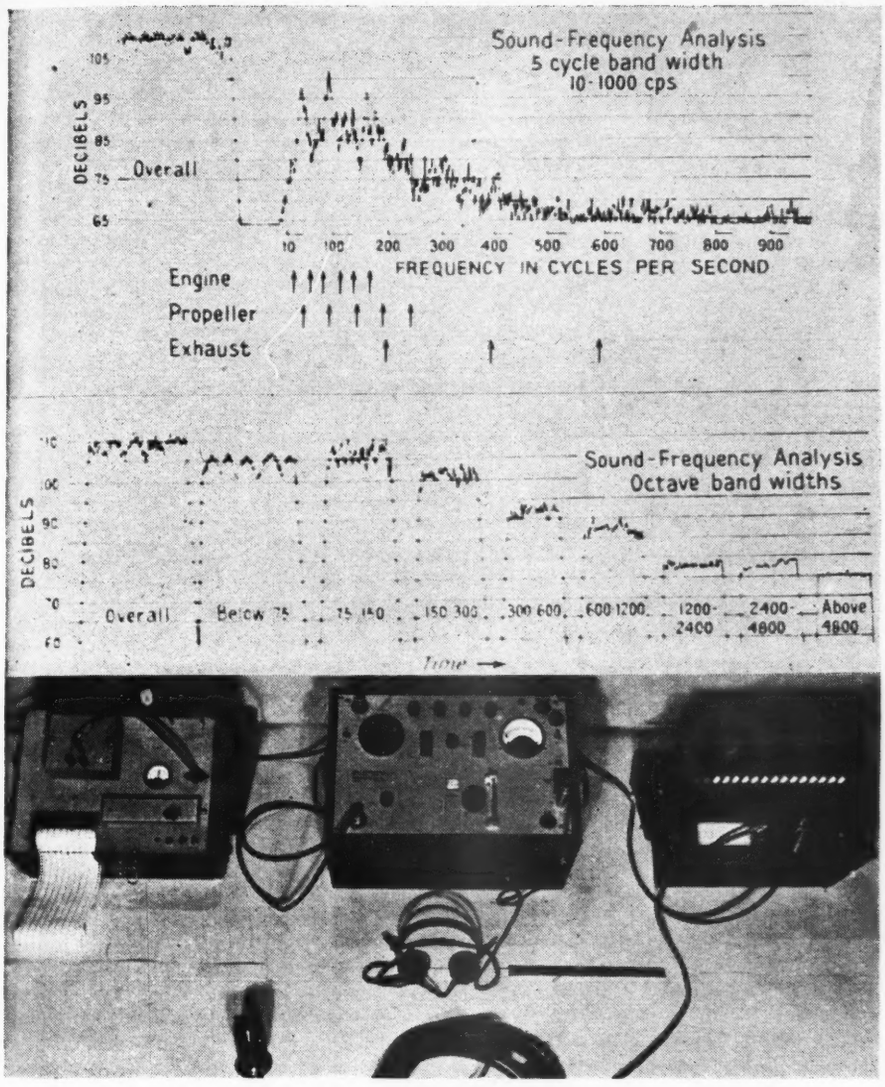


FIG. 3

auditory discomfort. Yet designers must perform this modern miracle shown in Fig. 2 with a fluff treatment weighing less than ½ lb. per sq. ft. of wall area.

We may go a long way towards making that living-room reader comfortable but to do it effectively we must know (1) what noises are annoying; (2) what frequencies and intensities of noise can be tolerated; (3) what lightweight materials are effective in attenuating those frequencies, and last but most important; (4) how to install these materials so as to isolate the passenger from the outside roar and structural vibration.

The statement that tomorrow's planes will be jet-propelled and the noise and vibration will be almost totally absent, is wonderful if true. However, the engine installation shown on the lower sketch of Fig. 2, using a propjet or propeller-turbine arrangement appears to be much more efficient than the pure jet, and with the continuance of whirling propellers at high tip-speeds, the noise problem may continue to plague designers and airline operators unless we can install "silent cabins".

Possibly we in the aircraft field are not using the proper psychology on the public in talking of "noisy" airliners, of "sleepless" nights near suburban airports, of the "staccato" of the small private plane. True, aircraft are noisy and will probably remain annoying to the outsider as long as we have reciprocating engines or turbines with propellers rotating at blade-tip velocities approximating the velocity of sound.

Few transport planes can compete with the 60–70 db noise level of a passenger automobile operating at 30 mph., or the 85 db of an air-conditioned coach on a streamlined train traveling at 50 mph., or even with the 90 db of the well-maintained city trolley. However, it may not be generally known that in most cities the overall noise near a street car crossing, at a downtown business corner may reach 95 to 105 db without much public complaint.

The overall noise levels in some city buses at 30 mph. may exceed 100 db, but conversation with passengers three seats away is possible in a normal speaking voice because of the predominance of low-frequency noise and of the low intensities in the 1,000 to 3,000 cps. speaking range.

The average businessman takes traffic noise for granted and necessary and is not overly annoyed thereby. The airplane noise is relatively new, however, and the irritations of passing planes are periodic and disturbing. We may accept these too, in due time.

Aircraft acoustics can be developed to protect the human ear against noises of certain frequencies, if psychologists and ear specialists can acquaint the plane designers with the frequencies and maximum intensities limiting passenger comfort.

Using the sound testing equipment shown in Fig. 3, Convair has tested many airliners and private planes in the last few months. You will recognize the Western Electric sound analyzer No. RA-277F in the center, the Western Electric octave band pass filter No. RA-363 on the right, the Sound Apparatus Co. inked paper recorder No. FR-137 on the left and the Western Electric dynamic "salt-cellar" microphone No. 633A in the foreground. With this equipment, either the complete spectrum analysis from 100 to 10,000 cycles, as shown above, can be made of a noise source in 1½ min. or the shorter octave band analysis from below 75 to above 4,800 cycles can be made in 45 sec. Each type of recording has its specific purpose; the spectrum analysis aiding in the detection of "beats" and specific sources of noise; the octave band analysis offering the best comparative method of studying the overall effectiveness of acoustical treatment and passenger comfort.

Several years ago the writer wished to select the acoustical material best suited to a specific frequency range

FIG. 4

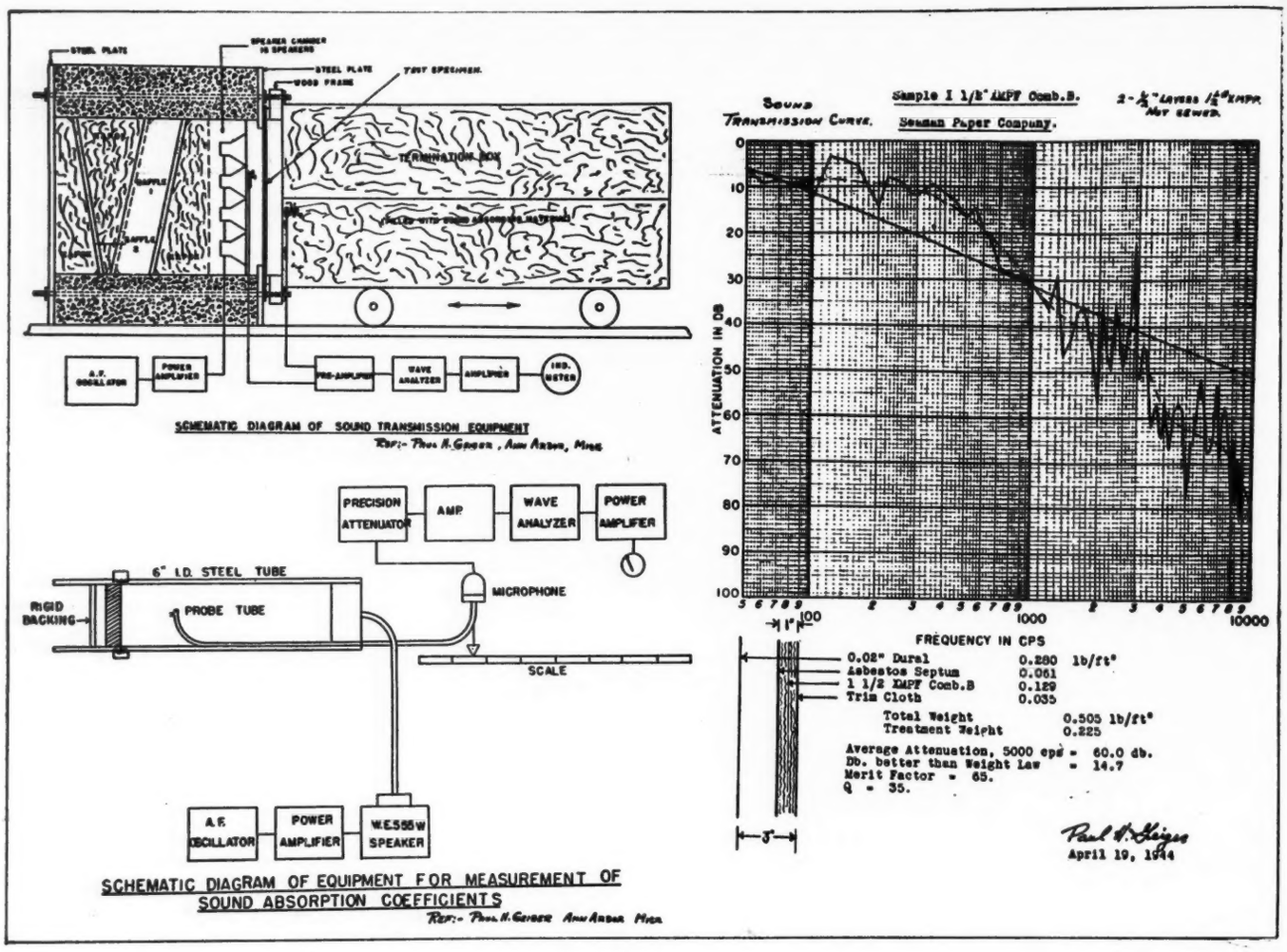


FIG. 5

and by means of the small and inexpensive "sound-box" shown in Fig. 4, transmission tests were made on several aircraft structural combinations in 18-in. square panels. By using the single calibrated microphone on each side of the test panel and by carefully sealing noise leaks around the specimen, the resulting test data proved to be quite comparable. In fact, it fell in line with tests made several years before by the Electro-Acoustic Laboratory at Harvard under the direction of Dr. Leo Beranek and by Dr. Paul Geiger at the University of Michigan Acoustical Laboratory.

Fig. 5 shows the considerably more elaborate test equipment used by Dr. Geiger in transmission and absorption tests on acoustical material. Similar setups exist at Harvard. While the fine work done in 1941 by Dr. Beranek and his Harvard colleagues and more recently by Dr. Geiger at Michigan in sound transmission and absorption coefficient determinations is acknowledged and appreciated by the aviation industry, there must be a closer correlation of acoustical theory with practice.

Possibly the full-scale Convair Sound Cabin method of testing may eliminate some of the unknowns or unattainables of previous laboratory procedures and will give the industry a new and simple tool for comparative sound attenuation tests on the ground. Both the simple Convair box method and the complex college test methods, however, result in transmission curves similar to that shown on the right of Fig. 5.

In both methods the standing waves and resonances existing in the test chambers or specimen nullify much of the accuracy of the results. The dashed "average" curve would be equally usable in comparing materials without the confusion of the "peaks" and "troughs". Many pages of such transmission curves for various combinations of materials may be found in Harvard Report No. 1543, *Principles of Sound Control in Airplanes* but in all, the same typical notch will appear. Fairing an average curve on the sawtoothed data indicates that the materials commonly listed in tables of merit factors at 5,000 cycles or "Q" factors at 3,000 cycles may be very similar in efficiency, with only negligible differences. Possibly cost per sq. ft. or ease of installation might be a better criterion than some of these acoustical transmission curves.

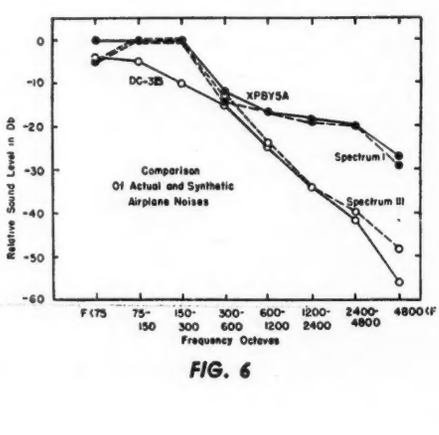


FIG. 6

Inasmuch as both the 6-in. ID. steel tube used by Dr. Geiger and the 8-in. square impedance tube used by Dr. Beranek test only the normal incident sounds on the sample, whereas in aircraft the sound level is reduced by both normal and grazing incident absorption, it would appear that the Convair Sound Cabin method of checking absorption on full-scale fuselage specimens is a more practical method of checking flight article results.

For the Harvard 8-in. square cross section impedance tube method Dr.

Beranek states, "the absorption coefficient can be measured accurately only up to 800 cps. Measurements can be made with fair accuracy to frequencies as high as 1,500 cps, but interference due to cross resonances prevents measurements at higher frequencies. The range of frequency measurement could be extended by decreasing the size of the tube cross section, but then errors due to too small samples and disturbances due to the size of the microphone become larger".

Before leaving the human factor of otological research versus passenger comfort to some future psychologist, it may be well to recall the interesting experiments performed at Harvard in 1941 under the leadership of Dr. S. Stevens, on human subjects working in a noise field 90 to 115 db. The Psycho-Acoustic Laboratory Report OSRD. 274, *Noise Reduction in Aircraft as Related to Communication, Annoyance, and Aural Injury*, indicates that two synthetic noise spectra were used, as indicated in Fig. 6; Spectrum I representing that similar to an XPBY-5A airplane, with the 1,200–2,400 cps. octave only 20 db below the 75–150 cps. octave band level; and Spectrum II similar to the DC-3B airplane noise distribution, with the 1,200–2,400 cps. octave approximately 34 db below that at the 75–150 cps. octave. The same overall noise intensity was maintained in both spectra, the octave band components of intensity differing.

Under this noise stimulus Dr. Stevens reports that subjects rated their annoyance approximately as shown in Fig. 7. The right chart indicated that of 32 subjects tested, 50% believed that the XPBY-5A spectrum at 105 db overall (1,200–2,400 cps. octave intensity of 85 db) was more annoying than DC-3B spectrum at 115 db overall (1,200–2,400 cps. octave intensity of 81 db). The left chart indicates that direct communication in the presence of noise permitted 70% articulation under the DC-3B Spectrum III and only 10% articulation under the XPBY-5A Spectrum I.

It is interesting to note that although the DC-3B noise spectrum is claimed by some to be comfortable, the spectrum at 95 db overall noise level would permit only 80% articulation at 6 to 9 ft., 70% at 100 db, 45% at 105 db, and 18% at 110 db.

The standardized method of presenting aircraft noise survey data shown in Fig. 8 was firmly established by the Harvard group early in 1941 and has been a great aid to the industry in presenting comparable results. The DC-3B transport, with the pilot's position overall noise level of 111 db in a normal

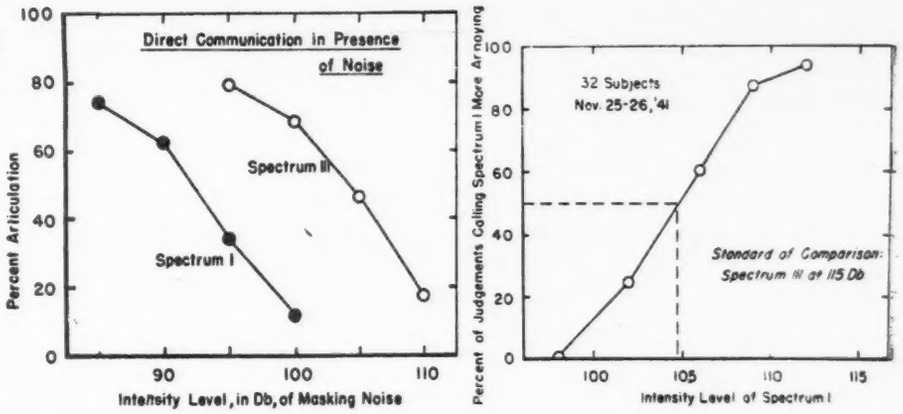

Direct Communication in Presence of Noise
Spectrum II
Spectrum I
Percent Articulation
Intensity Level, in Db, of Masking Noise
32 Subjects
Nov. 25-26, '41
Standard of Comparison: Spectrum III at 115 Db
Percent of Judgements Calling Spectrum I More Annoying
Intensity Level of Spectrum I

FIG. 7

cruising condition (1,850 rpm., 600 hp. per engine, and 160 mph.) has been used as a criterion of satisfactory cabin noise level by many airline operators. The low (75–150 cps.) and speech (1,200–2,400 cps.) frequency octave comparisons on this airplane are interesting, as shown in the table below.

Four bright spots appear in the sound picture that will permit the high-powered, speedy transport of tomorrow to meet the passengers' comfort standards.

First, that much fine research has been and is being done by such laboratories as Harvard, Michigan, Wright Field, Convair, and many others in developing methods of noise level prediction and acoustical treatment tests.

Second, a generous response is being made by West Coast otologists, college scientists (physiologists, and psychologists in getting together in round-table discussions and research to determine the noise intensities and frequencies most conducive to "aural annoyance" and "fatigue", and indication of the region to be tackled with the proper lightweight soundproofing.

Third, Convair Sound-Cabin tests indicate that a simple, economical way is available not only to test in full-scale the designers' dreams but also to provide a portable laboratory in the actual noise field for physiological and fatigue studies of human guinea pigs. Fourth, that there are indications from tests made by Convair and others that the use of a lightweight "inner cabin" or "thermos-bottle" principle of quieting planes may greatly increase in the near future.

Noise Levels By Location In Aircraft

Location	*OA.*	*75–150 cps.*	*1,200–2,400 cps.*
Pilot's Position	111 db	104 db	75 db
Forward center cabin	110 db	106 db	66 db
Aft center cabin	98 db	92 db	62 db

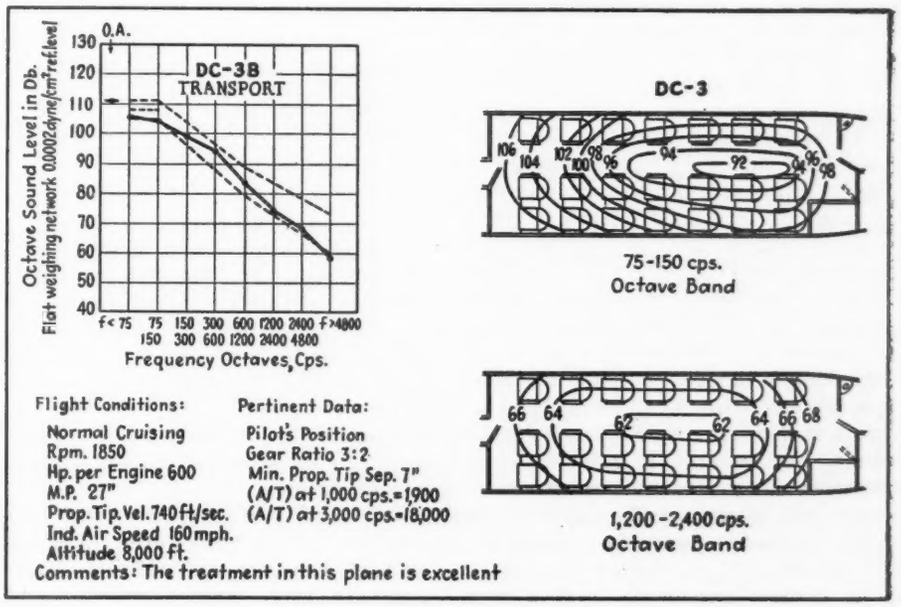


FIG. 8

Keep That Overhead Under Your Thumb

PART VI OF A SERIES

By **CHARLES A. PARKER,** *Flight Service Division, Robinson Aviation, Inc., Teterboro Air Terminal, Teterboro, N. J.*

Precise proportionment and allocation of common expenses will lay that solid working foundation needed for building the profit-healthy field operation. Author Parker tells how, illustrating the methods with practical, detailed tables—which you may use as a pattern for your own accounting.

WHEN AN AIRPLANE is operated for revenue, overhead is introduced in determining the cost of operation. Salaries, general insurance, rent, light, heat, telephone, and the like, are the burdens of commercial operation, hence each revenue-producing activity must bear some part of this overall expense. Accordingly, rates must be charged which cover these factors—or else the operator will "go in the hole."

Flight activities must, of course, carry their share as well as ground services. Each airplane supports some portion of the amount charged to the flying division of the business. The total cost of operating an airplane then becomes: Fixed expense, plus direct operating expense, plus overhead.

In apportioning overhead, the operator must charge each unit correctly, in order to have as true a statement of costs as possible. He must operate at rates that will attract trade, yet not be out of line with competition.

The basic breakdown of overhead lies between ground services—hangar, supply, and shop—and the flying operations. If selling is engaged in, it too should be considered. Charges can be made on the basis of floor area used by each department. For example, if ground services occupied 75% of the floor space and flight operations had the balance, overhead would be apportioned at the rate of 75 and 25%, respectively.

A further breakdown between units within these divisions can also be made. For instance, if shop, storage, and supply used 20, 45, and 10% of the space allotted to ground service, each of these subdivisions would be charged with that proportion of the area for which ground services was indebted.

In early CPTP work, the CAA permitted an overhead allocation based on the portion of total earnings that this branch produced; thus, the more the unit produced, the greater was the proportion of total overhead it had to carry. But this amounts to penalizing the more profitable parts of the business and so does not arrive at a fair determination of what proportion of the whole any department shall pay.

Table I—Space Charges

Activity	Area sq. ft.	Percentage Of total
Hangar, retail storage	4,860	60.8
Hangar, company planes	1,540	19.2
Stock dept., 10 x 20	200	2.5
Shop, 70 x 20	1,400	17.5
Total	8,000	100.0

For practical purposes, the allocation of overhead on the basis of area occupied will be adequate for the average airport business.

It is not difficult to determine what an airplane has earned during a given period. However, to calculate future costs and rates, certain estimates must be made. These can be based reasonably well upon past experience, plus a little careful analysis. Revisions can be made whenever operational data are obtained and compared with original predictions. The principal intention here is to show the exact composition of the total costs of operation, and thus go on to determine how they can be apportioned with some degree of equity. The need of adequate rates in excess of basic aircraft costs will then become self-evident.

At this point, let us set up, in our imagination, a small operating company —call it XYZ Airways—and outline its income and costs of operation, illustrating how they are arrived at, and showing the application of overhead.

Assume that our fictitious company has leased operating rights of a small municipal airport, with 80 x 80 hangar and 80 x 20 lean-to containing office, shop, and stockroom. Income is from hangar rental, gas and oil sales, mechanical work, and a small stock for resale. The company owns two planes—a 65-hp. two-seater and an 80-hp. 3-place cabin monoplane, both used for student, rental, sightseeing, and occasional charter flights.

The owner of the company also runs the business and holds commercial and instructor ratings. He is assisted by a second pilot-instructor. A mechanic and helper are employed regularly, with a second helper assisting weekends. An office girl comes in five days per week. A fair business is enjoyed.

It is assumed that the office girl, the pilot-manager, and the second pilot-assistant manager participate in the overall activities and in the common operation of the company. Hence the salaries, except those of the mechanics, are considered as spread over the whole business. If the second pilot were only engaged in flying, then his salary would only apply to the flying division. With a larger setup, further subdivisions of salaries would have to be made.

From the size of the facilities given, the floor space used by the entire business totals 8,000 sq. ft. Amounts occupied by each division are shown in our accompanying Table I.

It is also assumed that monthly costs include rent to the town, light, heat, power, telephone, taxes, salaries, adver-

Table II—Allocation of Overhead

Hangar, retail business	$653 x 60.8%	$398.00
Flying services	653 x 19.2%	125.00
Stock	653 x 2.5%	16.00
Shop	653 x 17.5%	114.00

tising, travel, depreciation of equipment, printing, postage, and any other small items—totaling, let's say, $653.

Table II gives allocation of this general overhead—items not directly chargeable to any one division, but over-riding the entire activities.

Because a similar amount of space is occupied by each airplane, basic overhead would be $62.50 each. But if cost of operation of a specific plane is desired, it's necessary to consider precise operational expenses incurred by this plane (see Table III). Here, expenses would be based on wholesale prices.

At the rate of $7 per hour, it appears that the operator cleared $1.49 per hour, or a total of $74.50 per month. This is a fine return and, if continued, would total $894 for the year. Because it includes *all* the expenses incident to operating the airplane, the operator is not being lulled by a false sense of profits.

Cost of Commercial Operation

When reducing costs to an hourly basis, note that the airplane cost, prior to overhead, was $4.16 per hour, and that overhead was $1.25 per hour. This shows why those who do not consider overhead when setting rates, do not make the profits they anticipated.

In the illustration just given, it was assumed that 50 hr. were flown during the month. What would the plane have earned if it had flown less than this fairly substantial amount?

In this case it is necessary to assume that rates and overhead remain the same. From Table IV it can be seen that the airplane had to fly 400 hr. before annual overhead charges were covered. It is to be noted that any assumptions made in this table closely approximate those in actual practice. At any rate, there is no reason why an operator cannot set up at least a rough analysis of his costs. With any operational data at all he can obtain a good idea of what income his various units have brought him and thus judge the adequacy of his rates. He should be able to estimate what must be done in order to break even. In addition, he may make some trial calculations with regard to new equipment and thus form some idea of what it must earn.

From past operations, the operator can at least see how his charges stand up economically—specifically which aircraft are showing results.

Shop Costs

In shop operation, three items go to make up the cost of a job—materials, labor, and overhead. Here, overhead may be allocated on the basis of floor space, which in turn can be expressed as a percentage of labor cost.

Table III—Airplane Hourly Cost

Direct operating expenses	
Gas	$1.00
Oil	.05
Maintenance and repair	1.00
Overhaul (every 500 hr.)	.30
Total	$2.35
Multiplied by 50 for month	117.50
Fixed expenses	
Hangar, per month	$20.00
Insurance, per year	450.00
Depreciation, 20% of $2,000	400.00
Above three items reduced to monthly basis	90.75
Add direct expenses	117.50
Overhead allocated on space used	62.50
Cost per month	$270.75
At 50 hr. per month, cost per hr.	5.41

Suppose that a small shop occupies 17.5% of the total floor space and that the administrative overhead of the company is $653 per month. This department would then be charged with 17.5% of $653, or $114.

A mechanic and helper work 6 days per week, 8 hr. per day—total 208 hr. per month. For this they are paid $260 and $108 per month, respectively, or at the rate of $1.25 and $0.50 per hour.

Total monthly *costs* of operation would then be as follows:

Labor, mechanic	$260.00
helper	108.00
Materials	150.25
Shop repairs, paint, etc.	55.00
Overhead	114.00
Total	$697.25
Shop *income* meanwhile has totaled:	
Labor, 150 hr. @ $2	$300.00
140 hr. @ $1	140.00
42 hr. company craft @ $2	84.00
60 hr. company aircraft @ $1.00	60.00
Parts	175.50
Total	$759.50
Less shop cost for month	697.25
Margin of income over cost	$62.25

Once data is collected on any shop operation, the owner will be able to determine where he stands on the charges he is making. In drawing up customers' bills, overhead does not appear. Only labor and materials are shown, because overhead is contained in the retail labor charge.

In fixing the cost of a customer's job, or when bidding on a contract, overhead can be allocated as a percentage of the labor.

In our example it has already been shown that salaries for labor total $368, and that shop overhead is $114 for the same period. This makes overhead just 31% of labor costs, at these rates, so that this charge can be set at this percentage—i.e., the percentages of whatever the labor is for any job.

Suppose that a job incurred the following *charges to the customer:*

Labor, 10 hr. @ $2	$20.00
4 hr. @ 1.25	5.00
Materials, retail	15.75
Charge to customer	$40.75
Costs to the operator would then be:	
Labor, 10 hr. @ $1.25	$12.50
5 hr. @ 50c	2.50
Materials, cost	12.00
Overhead, 31% of $15 labor	4.65
Total	$31.65

Margin for shop....$40.75 less $31.65 equals $9.10.

Shop Charges

There are three methods of charging for shop work: Hourly basis, with no quotation for total cost; cost-plus-fixed-percentage; and contract. Of these, the first will prove the most feasible for the new operator. Unless he has a good knowledge of maintenance and repair, he should be cautious of accepting contract work.

With an experienced mechanic, or if data has been accumulated over a long period, the operator can set up a system of flat rates where fixed charges include the incidentals that accompany any overhaul job. Here, of course, the parts

(*Turn to page* 143)

Table IV—Costs And Income For Varying Amounts of Operation

Hr. Flown Per Yr.	Fixed Expense from Prior Calculations	Direct Operating Expense @ $2.35/Hr.	Overhead	Total Cost Monthly	Monthly Income @ $7/Hr.	Net For Month	Net Per Hr.
100	$90.75	$19.55	$62.50	$172.80	$58.30	−$114.50	....
200	90.75	29.30	62.50	192.45	118.25	−74.20	....
300	90.75	58.75	62.50	212.00	175.00	−37.00	....
400	90.75	78.30	62.50	231.55	233.35	+1.80	.... *
500	90.75	97.90	62.50	251.15	291.65	+40.50	0.97
600	90.75	117.50	62.50	270.75	350.00	+79.25	1.58

* Approximate point of breaking even.

TAGGING THE BASES

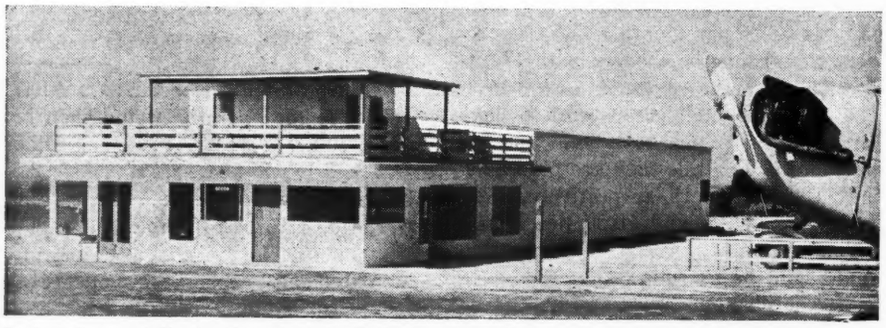
Emphasis on Service Pays Off Roundup Reports Show

"If people are going to own airplanes, someone must take care of them. Owners like a place that can do everything."

This is the business philosophy that has brought an increasing load of conversion work to Spartan Aero Repair Station at Tulsa, Okla., since Jan. '45, when the firm expanded its facilities to handle all types of surplus aircraft. Spartan receives the planes in war condition, and when they leave a few weeks later, engines, propellers, instruments, radio, and airframe have been completely reworked and put in flying condition.

Among those recently licensed were planes for George Coleman, Miami, Okla.; Ross Beech, Hays, Kan.; Jack Osborn and Henry Reynolds, Pampa, Tex.; Charlie Quinn and Earl Stamps, Tulsa; M. L. Woosley, Oklahoma City, and a fleet of 10 for Harry Larson, operator of Twin City Aviation Co. at Chippewa Falls, Wis.

Spartan occupies four large hangars at Tulsa's airport, and no one has yet been refused hangar space, whether overnight or on a permanent basis. Even without conversion work, maintenance, checking, and repair of approximately 100 planes stored on a permanent basis is a major business that Spartan predicts will grow as more military aircraft are converted. The business of cleaning airplanes has, in itself, grown to require a dozen men. When a visitor sees a shining fleet of Lodestars, Beechcraft, and other planes in Spartan's hangars, he rarely misses buying a polish job for his own ship.



Designed especially for San Joaquin Valley's semi-arid climate is this airpark headquarters at Bakersfield's newly-opened La Cresta Airfield. Providing sun-shaded observation deck, inexpensive building houses administration offices, charter and flight ticket offices, restaurant and restrooms.

Revival of Ohio's Dawn Patrol, well known prewar flight stimulator, drew 150 planes to Mansfield. Here George H. Scragg, (left) Patrol v.-p., watches as Mansfield's Mayor Roy W. Vaughan receives engraved invitation to Great Lakes Regatta at Cleveland from Sesquicentennial Queen Mary Dublin, who was flown to Mansfield by Don Fairchilds (right).

First Region—Aircrafters, Inc., has purchased airport at Rehoboth, Del., consisting of 130 acres on which there are four runways, longest being 3,400 ft. Firm uses a Cub Coupe, a Taylorcraft, and Piper J-3s for instruction under Forrest P. Wenyon. Dormitory facilities take care of overnight guests, and several cottages and T-hangars are planned. C. C. Flatt is Pres. of Aircrafters, and other officers are James R. Young, v.-p., and William M. Wright, sec'y.-treas. . . . Revere Airport was scheduled for early operation by Revere Airways, giving suburban Boston another field for lightplanes. Julius Goldman, v.-p. and general manager of firm, says airport will make available primary and advanced flight instruction, sight-seeing, and charter service. Richard Hoag is pres. of firm; Richard A. Berenson is treasurer, and Win Pettingell, flight director. . . . Flight schools operated by Nelson Aviation Service, Lippitt Aviation Corp., Allen Airways, and Connecticut Aviation Corp., all located at State Airport, Hillsgrove, R. I., have received CAA approval.

Second Region—Southern Airways of Birmingham is now in operation at Mobile Municipal Airport, with Ike F. Jones, v.-p., in charge, and Julius L. Boggs as manager. George Hilliard, transferred from Southern's operation at Atlanta, is service manager. Frank W. Hulse is Southern's president. Company is exclusive distributor in Alabama for Beechcraft, Piper, and Republic Seabee. . . . Johnson Aero Service, operator of Gilbert airfield at Winter Haven, Fla., has added a classroom for ground studies, following approval as a veterans' flight training center. Reed Johnson is manager of field. . . . Milford Airport, offering flight instruction at Dickerson Lane, Falmouth, Ky., is dealer for Aeroncas. . . . Improvements at Marymount (Fla.) Municipal Airport will include a new hangar and an annex building, plus additional taxi strips to complete triangular runway layout.

Third Region—Tufts-Edgcumbe, Inc., of Chicago's Pal-Waukee Airport, has taken operation of Elmhurst, Ill., airport, formerly run by Willis Rollins of Rollins Aviation Co. Tufts-Edgcumbe offices will remain at Pal-Waukee with continuation of Piper, Fairchild, and Edo agencies. . . . Victory Field near Warsaw, Ind., home of Victory Sky Pilots, Inc., handles Aeronca, Fairchild, Continental engines, Firestone tires, and Motorola radio equipment. . . . Bemidji, Minn., is one of smallest cities to possess an airport with 8,000-ft. runways. Built by Government during war, $1,000,000 airport, recently dedicated, may be used as a scene for cold weather air operations. . . . Twenty-five students have entered new aviation course at U. of Ill. under J. W. Stonecipher, chief flight instructor. . . . Merrill C. Meigs, chairman of Chicago's Aero Commission, has recommended that city establish a flight strip on Northerly Island, a part of 1933-34 World's Fair. Strip would be primarily for personal aircraft. . . . Ohio Dawn Patrol, inactive during the war, has been revived by veteran aviators of northern Ohio. First flight of season drew 150 craft to Mansfield Airport, converging point. Twenty-four additional airport visits are scheduled during year. Edward P. Honroth, operator of Sky Haven Airport at Northfield, is pres. of Patrol. . . . Indiana Flying Farmers have scheduled a field day on Aug. 1 at Purdue U. . . . John J. Dow is manager of Chicago-Hammond Airport, successor to Ford-

Lansing Airport, at Lansing, Ill., with dealerships in Piper, Beechcraft, Stinson, Fairchild, Bellanca, and Republic Seabee aircraft. F. R. "Hank" Ford, as chief pilot, handles flight instruction. Additional services include service and repair, charter, and rent-a-plane. Concessionaire space is available.

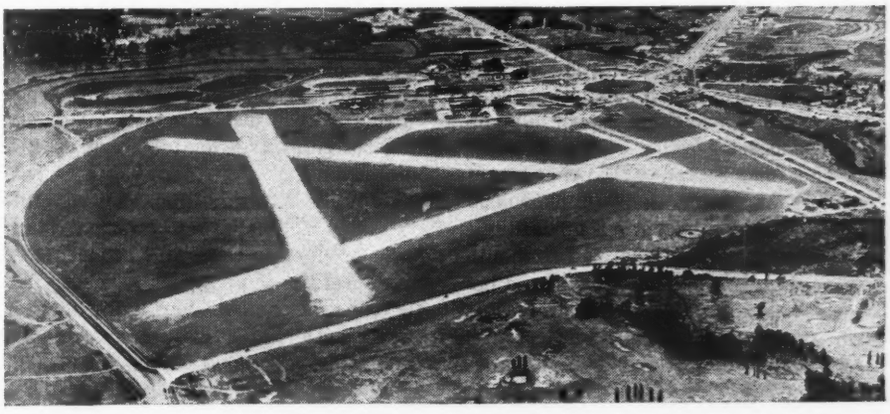
Fourth Region—New Mexico Corporation Commission has granted authority to Mrs. Eleanor Graham to operate charter, scenic, and student aircraft services at Socorro, N. M., and to E. A. Elkin for operation of similar services at Lovington.

Fifth Region—Address of Fulkerson Aviation Service, dealer for Aeronca and Bellanca, is Box 808, Gillette, Wyo. Offering all types of commercial operations, Fulkerson also handles Continental engines, General tires, BG ignition, and Ranger and Heath radio equipment.

Sixth Region—Brandt, Perkins and Brandt, new firm of Air Force veterans, holds a temporary lease on Alicia Airport, Marysville, Cal., and will establish a repair and service station and sales agency. . . . Wesley Martin, manager of airport at Yerington (Pizen Switch), Nev., says he has "nothing to sell except goodwill." There is no tie-down charge, and rides to town are free. . . . Eighteen operators have formed Sonoma County (Cal.) Aviation Assn., affiliated with Santa Rosa Chamber of Commerce. Officers are J. S. Barham, pres.; I. B. Puffer, v.-p., and J. W. Salz, sec'y.-treas. . . . New personnel at Las Vegas (Nev.) Alamo Airport are Richard F. Dick, airport manager, and Carl F. Crawford, flight operations manager. George Crockett, general manager, reports a new Cadillac limousine service to town, also a new second-floor cafe overlooking airport. Company is Bellanca and Continental distributor and supplied is 77, 80, 91, and 100 octane gas.

Seventh Region—Ernest R. Cluck, manager of Seattle's King County Airport, is looking for airline operations to move to Bow Lake Airport, wants personal plane owners to feel at home, and makes no tie-down charge for transients. . . . Island Airways proposes to link Seattle with San Juan Island with two daily passenger and cargo stops at Port Angeles, Port Townsend, Everett, Bellingham, and Seattle on flights from island points. W. A. Paull, heading company, plans to establish, throughout San Juan group, a series of small landing fields off main routes. . . . Oregon's Sportsman Pilots' Assn. recently made its largest flight since war in a trip to Seaside.

Pal-Waukee Airport, Wheeling, Ill., is Parks Aircraft's newest base. Firm is Ercoupe distributor, and it features complete maintenance and overhaul shops. Offices are across highway at lower left. Note T-hangars for private owners.



Released by Navy for civilian use, Camden (N. J.) Airport, seen here in aerial photo, is conveniently located 4½ mi. from center of Philadelphia. Field is being converted to provide elaborate facilities for private flyers, and is operated by Edward J. Walz (Lt. Col., AAF) and Nicholas S. Ludington (Lt. Comdr., USNR).

AS THE OPERATORS SEE IT

Maybe you've run into a sales and service snag, face some overhaul hurdle, are grappling with a flight teaching tangle, or seek guidance in the maze of maintenance. Whatever the perplexity, it's "fair shooting" here in our operators' corner. Answers, and criticisms of answers, will be paid for at AVIATION'S usual rates. Welcome, too, will be photos or sketches which "point up" the problems.

QUESTION 2.—Do you make a landing charge when a visiting pilot uses field facilities for a few hours but does not buy fuel or service? What are your reasons for doing or not doing this? Do you find that this landing charge is expected by visitors?—R.K.

Answer: "We do not make a landing charge to visitors even if there is no service involved. We have always felt a free exchange of landing privileges between privately owned airports would have a tendency to encourage private flying. As a general practice, most visitors do not expect to pay for using the field, as there are very few privately owned airports that do make a charge.

"There is a tendency toward making a nominal fee for landing and we realize that maintenance of any airport is a large item, but we doubt that a landing fee assessed to transients would be the practical method to offset this. We are of the opinion this slack should be taken up from volume through other airport channels."—*E. Gomer Jones, Jones Flying Service, Sullivant Ave. Airport, Columbus, Ohio.*

Readers Are Invited to Answer—

Question 3.—Which of these sources of new business do you consider the best: (A) Customer goodwill, (B) billboards, or (C) local newspaper advertising? What has been your experience with these media? Have you used successully any other method for attracting business to the airport?—D.H.

Question 4.—In the initial step of our fixed base set-up, we are confronted with the problem of site expense. Do you consider that a main highway passing an airport is of sufficient advantage to compensate for the relatively high tax charges on the land, as compared to a location on a secondary road where there is little through-traffic, but where taxes are considerably lower? —A.M.

Profits Balanced By Reconversion Costs

PART I

By **RAYMOND L. HOADLEY**, *Financial Editor, "AVIATION"*

MOST AIRCRAFT COMPANIES will be content to break even on 1946 operations, but next year should see the industry back on a profitable operating basis.

Plane makers today have aggregate backlogs of better than $1,600,000,000 in unfilled orders. That's a much higher figure than appeared likely a few months ago, especially when it is considered how poorly the industry has fared recently with respect to government orders. The $200,000,000 to $300,000,000 in orders that some companies have on their books looks pretty impressive—until it is realized that reconversion, tooling, and development expenses will eat up most of the moneys the manufacturers are taking in this year.

Fairly complete data is now available on probable 1946 operations. Yet it's still rather difficult to be very precise on forecasting 1946 financial results. A lot depends on individual company bookkeeping; how development costs are prorated, and how helpful the tax carry-back provisions prove to be in offsetting sizable operating loses in this first post-war year.

While there are bright spots here and there among individual companies, a coast-to-coast survey indicates that small profits and even losses are frequently indicated for other concerns.

It all seems to add up to a general picture of nominal profits this year. But it's the industry's long term outlook that really counts, and here the situation appears much brighter. The industry already has written off 1946 as a mediocre year and has amassed large cash reserves to tide it over such a period. All plans and activities are pointed towards 1947 and beyond.

Republic Aviation Corp., for example, has one of the most diversified, large-scale production programs attempted by any aircraft company this year. Military, airline, and private flying markets are all major objectives of the company. Sales this year may run to $50,000,000. Company officials estimate 1947 volume at $80,000,000 and believe they may be able to double that amount in 1948. Net income for the first quarter was $546,000 or 55c. a common share on sales of $13,000,000, and further substantial profits are indicated for the full year.

Republic lists its unfilled orders at $84,000,000 and expects that additional contracts up to $45,000,000 will be received in the near future. This new business will include additional contracts for P-84 jet fighters, Army reconnaissance planes, and Rainbow commercial transports.

Some $30,000,000 in military business may be delivered in 1946. More than 5,000 orders have been received for the Seabee, with more than 50 distributors and 600 dealers handling the sales of this plane. Full scale production will be achieved within the next few months. Rainbow deliveries are scheduled for late 1947 and early 1948. Meanwhile the company will gross upwards of $5,000,000 on reconversion of air transports, a job that should be over by mid-Summer.

Grumman Aircraft Engineering Corp. probably will have military sales in the neighborhood of $40,000,000 this year. In addition it is scheduling production of 35 of the new Mallard amphibian executive craft at $90,000 apiece and may build approximately 50 Widgeons which sell for about $30,000. The total market for Mallards is estimated at 250 units. The production goal for aluminum canoes has been stepped up from 5,000 to 10,000 this year due to the influx of orders. The company should operate at a fairly substantial profit in 1946, although it is too early to set a figure on what the earnings will be.

Glenn L. Martin Co. expects 1946 sales of around $40,000,000 followed by a volume of $70,000,000 in 1947 (when deliveries start on its 202 twin-engine transport) and $100,000,000 sales in 1948. Earnings this year may fall somewhat short of covering the $3 a share present annual dividend requirements. Unfilled orders are close to $150,000,000, of which $80,000,000 is military. The outlook for Martin for the next couple of years is closely tied up with its future orders from the airlines as production of 350 of the Model 202s is said to be needed to write off development and tooling expense. After that an output of only ten a month will be needed to break even.

This year's business includes about $26,000,000 of conversions of military aircraft for airlines and a substantial spare parts business. Martin also is busy developing sales of Marvinol, a synthetic vinyl rubber-like plastic and other non-aviation products.

Bell Aircraft, with an investment of some $4,000,000 in helicopters, is building for the future. It plans to build 500 two-place helicopters for the civilian market this year. There is not much profit in the high speed research work (including the XS-1) this company is doing for the military, but it all helps to maintain an extensive engineering staff. Tax carry-backs will aid an otherwise rather unimpressive 1946 earnings outlook.

Fairchild Engine & Airplane Corp. has unfilled orders totaling around $72,000,000. This backlog consists principally of Army orders for C-82 Packets, which were being produced at the rate of eight a month in the Spring, with deliveries scheduled to continue until mid-'47.

This company is primarily a military

(*Turn to page* 140)

First of two important articles analyzing the manufacturing industry's cost of changing from war to peacetime operations—and what the change will mean to the year's profit and loss statements.

CONDUCTED BY FRANK ROCKETT

New Accuracies Attained With Radio Altimeters

Described and evaluated are two special war-evolved height-gaging instruments—the frequency modulation unit for low-level indications and the pulse modulation type for high altitude work.

TWO DISTINCT TYPES of radio altimeters have been developed during the war—one making use of a frequency modulated signal, the other employing a pulse modulated signal. The frequency modulation altimeter gives accurate low-level indications, while the pulse modulation unit affords accurate high altitude indications. Table I presents the operational characteristics of two representative sets of equipment.

The APN-1 frequency modulation altimeter is a development of an early Bell Telephone Laboratory unit. It has an accuracy within ± 5% of the indicated altitude plus a residual error due to carrier frequency interference over flat surfaces, such as landing strips or calm water, of ± 6 ft. on the low range and ± 60 ft. on the high range. Altitude is indicated on a conventional type instrument. On the low range the carrier is frequency modulated over a 40 mc. bandwidth, on the high range over a 4 mc. bandwidth, not including sidebands.

The pulse type altimeter, of which the SCR-718-C built by RCA is a recent model, is an outgrowth of early techniques of measuring the height from the ground of ionized layers in the stratosphere. In it the carrier is transmitted in 0.25 microsec. bursts of several watts peak power. Because it has a higher range than the frequency modulation set, it requires greater power. Pulses are transmitted at 98,400 a second for the low range; at 9,840 for the high range. At altitudes of 30,000 ft. and above, the indication error is consistent within 50 ft.

Principle of Measurement

All radio altimeters measure the airplane's height above the earth's surface by radiating a wave downward to the terrain or ocean. The wave is reflected back to the plane by the earth's surface. Time required for the wave to travel down and back at its speed of 984×10^6 ft. per second is measured, and in turn gives the indication of altitude. The methods of measuring the elapsed time between radiation and reception of the waves illustrate the fundamental differences between the two types of radio altimeters (see summaries in Fig. 1).

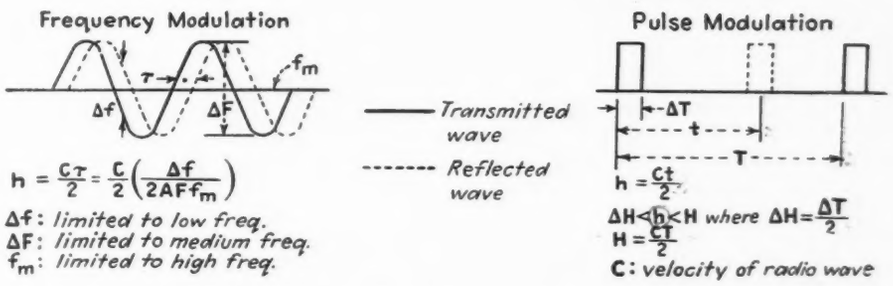


Fig. 1. Two basic methods for measuring absolute altitude.

In the frequency modulation altimeter, the radiated frequency (of average frequency f_m) is constantly changing (over the frequency range ΔF). At a particular instant, the radiated wave has a certain frequency. But by the time this wave returns by reflection from the ground the wave then being radiated has a different frequency (the frequency difference being Δf). The average difference between the frequency of the wave being radiated at any instant and the frequency being received at that instant is used to operate the indicating instrument, which is calibrated directly in altitude; the higher the difference frequency, the greater the altitude.

On Fig. 1 are indicated the ranges to which the various frequencies of this system are limited by practical circuit considerations. From them it is apparent that this technique becomes awkward at high altitudes.

The pulse modulation altimeter measures the interval between the transmission of the radio pulse and its return. The indicator consists of a cathode-ray tube of the type used for radar or loran indication, but it is much smaller and has a special type of display. A circle is traced around the face of the tube. A radial projection from this circle appears when the altimeter pulse is transmitted, and another one when it is received. The distance around the circle between the two projections, which corresponds to the interval required for the wave to make the round trip (time t), corresponds to the altitude. The circumference of the cathode-ray tube's screen is calibrated in altitude.

To give a readable indication, the reflected pulse must return after the pulse

(*Turn to page* 143)

Table I—Comparison of Radio Altimeters

Designation	*APN-1*	*SCR-718-C*
Modulation	frequency	pulse
Altitude ranges (ft.)	0–400; 400–4,000	0–5,000; 0–50,000
Weight (lb.)	25	75
Carrier frequency (mc.)	440	440
Radiated power	100 mw.	5–10 peak w.

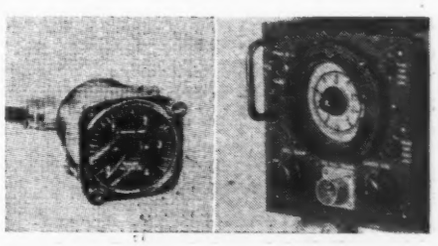
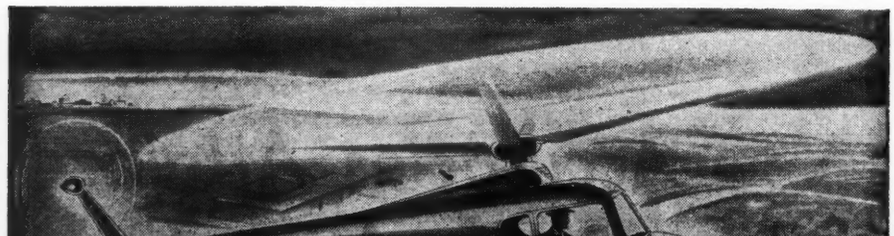


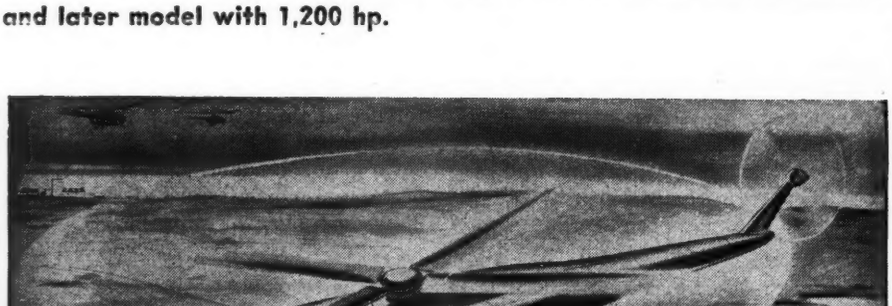
Fig. 2. Typical absolute altitude indicators. Left: For frequency modulation type instrument. Right: For pulse modulation type instrument.



Sketch of Doman-Frazier LZ-1 two-place experimental 'copter depicts teardrop fuselage design, also high-placed tail boom carrying anti-torque rotor.. Fixed tricycle landing gear is planned for this craft, which is to be powered by a 175-hp. Franklin. Top speed is to be 110 mph.

Doman-Frazier Reveals New 'Copter Projects

N. Y. C. firm plans early completion of small flight-research helicopter, which will be employed to test engineering aspects of two projected ten-place twin-engine transport designs, one to use total of 900 hp., and later model with 1,200 hp.



First stage in development of firm's transport 'copter design is HC-1, designed to carry ten passengers. This craft would have two 450 hp. engines under cabin floor. Somewhat slimmer HC-2 would have more powerful engines fore and aft of cabin. Dia. of 4-blade rotors of both types is given as 63 ft.

THREE NEW HELICOPTERS, two of which are in the medium transport class, are now under development by the recently formed Doman-Frazier Helicopters, Inc., 545 Fifth Ave., N. Y.

First of the series is the small LZ-1, a two-place craft intended for demonstrations and for the purpose of obtaining documentary evidence of vibratory stress levels native to the company's specialized rotor design. This design is not slated for marketing.

Completion of this initial craft at Stamford, Conn., is scheduled for an early date. It is to be of welded steel tube construction, covered with fabric and metal, and the power plant is to be a 175-hp. Franklin. Estimated performance is given as follows: Top speed at sea level 110 mph.; cruising speed at sea level 85 mph.; rate of climb 2,000 fpm.; service ceiling 15,000 ft.; and hovering ceiling 6,500 ft. Normal range with 30 gal. fuel is put at 238 mi.

Gross weight is planned at 2,050 lb., and weight empty at 1,550 lb. The four plywood-covered main rotor blades are to be of 36 ft. dia., with chord of 15.6 in. Rotor disk loading is given as 2.01 lb./sq. ft., and power loading as 11.7 lb./hp. Rotor speed is placed at 230 rpm. The anti-torque tail rotor, of the three-blade type with a 6.5 ft. dia., is designed to turn 1,500 rpm. at cruising.

Transport 'Copters

Designated the HC-1 and HC-2, only brief information is available on the intended transport types, but some visualization of these craft may be obtained from our accompanying illustration of the HC-1. This model is designed to be powered by two 450-hp. radial engines, unsupercharged and horizontally mounted, located under the cabin flooring. Seating is planned for ten passengers.

Among specifications of the HC-1 given are: Gross weight 8,900 lb.; payload 2,200 lb.; cruising speed 95 mph.; hovering ceiling 6,000 ft.; service ceiling 17,000 ft.; and rotor dia. 63 ft.

The HC-2 is planned as a further development of the foregoing design, with supercharged engines to be located fore and aft of the cabin. Specifications: Normal gross weight 9,000 lb.; normal payload 2,500 lb.; maximum overload gross weight 15,000 lb.; weight at which hovering is possible on one engine 8,800 lb.; cruising speed 100 mph.; range 350 mi.; normal hovering ceiling 9,100 ft.; approximate service ceiling 23,000 ft.; rated power available 1,200 hp.; emergency 1,600 hp.; and rotor dia. 63 ft.

Improved Funk Two-Placer Goes Into Production

Model F2B, powered by 85-hp. Continental, has 100-mph. cruising speed . . . . Craft has many "extras" on its standard equipment list.

DESIGNED AS A LUXURY cross-country personal plane, the new F2B has been put in production by Funk Aircraft Co., Coffeyville, Kan., with a schedule of 500 planes set to be built during the remainder of this year.

Developed from the company's prewar model, the F2B is powered by an 85-hp. Continental C-85 giving it a 100-mph. cruising speed. A test flight by an AVIATION correspondent showed this figure can be easily maintained at normal cruising rpm. The test flight also revealed a short takeoff run, high rate of climb, inherent stability, light controls and excellent stall characteristics. Soundproofing and dual engine mufflers keep noise below average levels.

Standard equipment includes tachometer, oil pressure and temperature gages, airspeed indicator, altimeter, compass, fuel gage, starter and generator, battery, radio receiver, navigation lights, illuminated instrument panel, cabin dome light, detachable landing lights, and wheel pants.

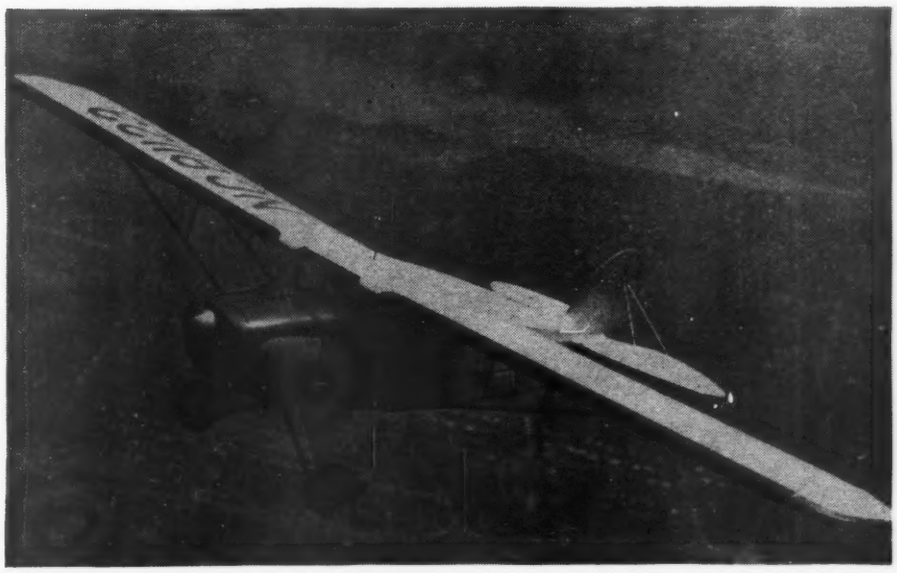
Dual wheel control is provided for the side-by-side seats, with heel-actuated brakes on the left side. The tail wheel, mounted on a hydraulic shock unit, is yoked to the rudder for taxiing. Pulling a spring-loaded pin, however, releases the yoke to make the wheel fully castering for ground handling.

The F2B's strut-braced high wing of NACA 4412 airfoil has two solid spars and truss-type wood ribs, fabric-covered. Tail surfaces are wire-braced steel tubular structures, also fabric covered. The fuselage is fabric- and aluminum-covered steel tubing with wood fairing.

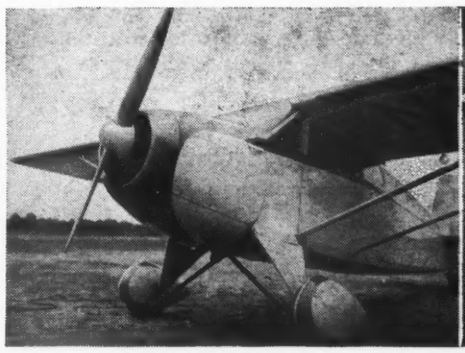
N. F. Howard, sales manager, reports that distribution is being handled through direct factory dealers, of whom more than 20 have been appointed. Current list price of the F2B, with the equipment noted above, is $3,695 FAF factory.

Specification and Data

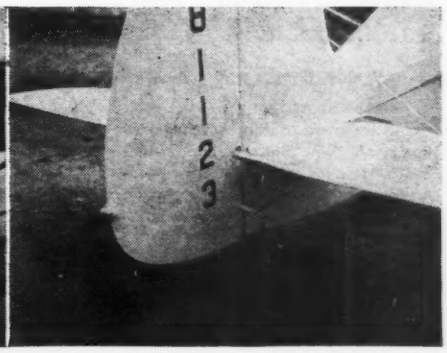
High speed (sea level)	112 mph.
Cruising speed	100 mph.
Landing speed	37 mph.
Climb (sea level)	800 fpm.
Takeoff distance	350 ft.
Cruising range (½hr. reserve)	350 mi.
Span	35 ft.
Length	20 ft. 1 in.
Height	6 ft. 1 in.
Caord	60 in.
Dihedral	1½ deg.
Gross weight	1,350 lb.
Empty weight	870 lb.
Useful load	480 lb.
Baggage	40 lb.
Wing loading	8 lb.
Power loading	18 lb.
Wing area	168.6 sq. ft.
Ailerons	11.5 sq.ft.
Fin	4.5 sq. ft.
Rudder	6.94 sq. ft.
Stabilizer	15.2 sq. ft.
Elevators	10 sq. ft.
Power	85-hp. Continental C-85
Price	$3,695 FAF



New two-place Funk F2B, designed for cross country work, is powered by 85-hp. Continental which gives 100-mph. cruising speed. Starter, generator, battery, radio, avigation lights, and other items, are included as standard equipment in list price of $3,695. (Rudy Arnold photo)



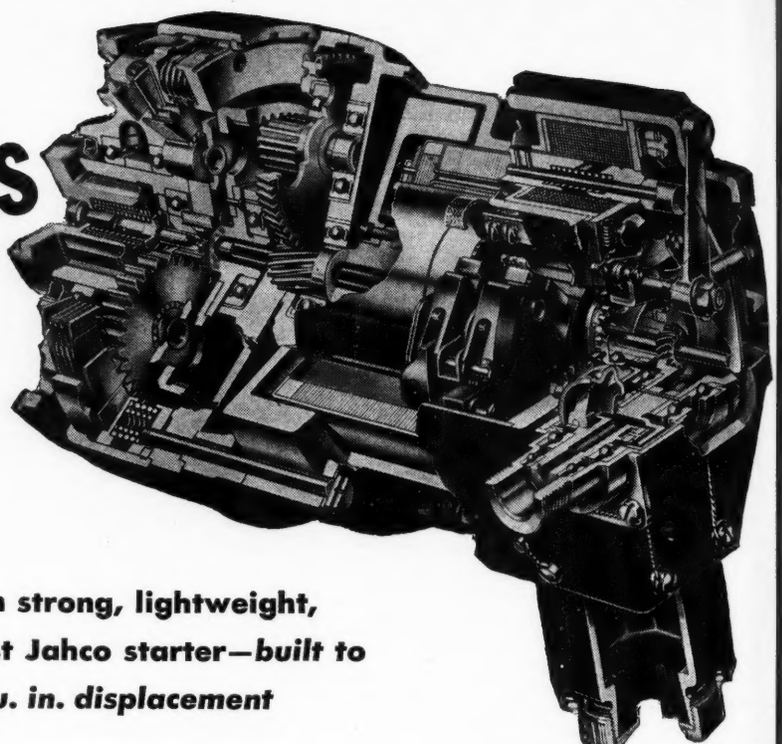
Side sections of Funk engine cowlings are mounted on piano hinges along top, so that unlocking of three quick fasteners (seen near bottom) gives access to power plant, which is equipped with dual mufflers that aid in keeping noise below average levels. (Aviation staff photo)



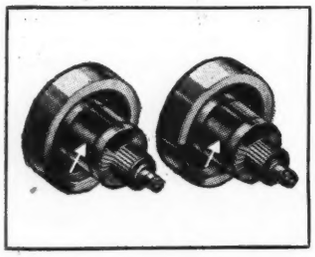
Closeup of Funk F2B empennage, showing yoke which attaches tail wheel to rudder for taxiing. Pulling spring-loaded pin below rudder releases yoke so that wheel—which is mounted on hydraulic shock unit—is fully castering for ground handling. (Aviation staff photo)

Only 39 Pounds

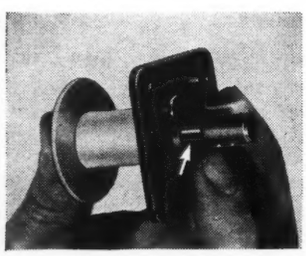
...but powerful enough to crank 3 dozen cars!



MONEL and "K" MONEL form strong, lightweight, corrosion-resisting parts in latest Jahco starter—*built to start engines up to 4360 cu. in. displacement*



MONEL ARMATURE BANDS (arrow)
These thin bands must hold fast despite the centrifugal stress generated by operating speeds of 24,000-25,000 rpm. For more information on Monel, write for *Technical Bulletin T-5.*



"K" MONEL PUSH ROD (arrow)
Of great importance here is the demand for an absolutely non-magnetic material. "K" Monel remains non-magnetic at all atmospheric temperatures. For more information on "K" Monel, write for *Technical Bulletin T-9.*

JACK & HEINTZ STARTERS have set new records for service stamina. At 50° F. below or at 160° F. above, these phenomenally light units develop enough power to start airplane engines whose displacement is equal to that of three dozen auto motors.

To help build-in such power and dependability, Jack & Heintz engineers carefully chose their metals. They specified metals whose strength and corrosion resistance permit parts to be made with the thinnest safe sections.

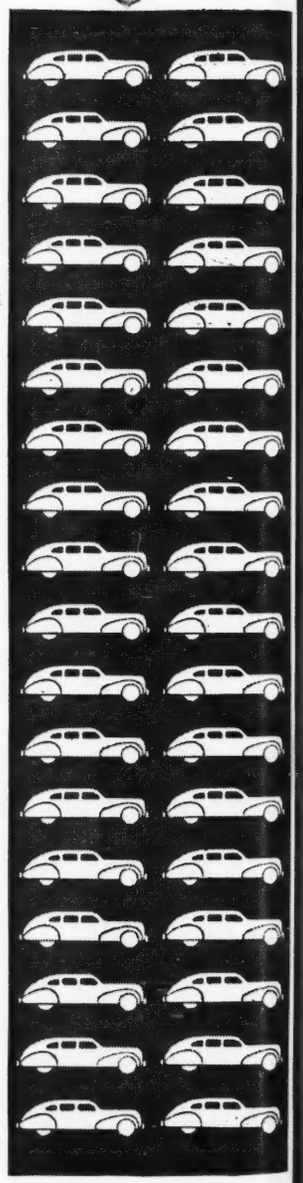
For example, they specified two of the INCO Nickel Alloys in the JH-4 starter shown above.

For the armature bands, which must be non-magnetic, resist corrosion by sea air and condensation, they chose Monel. A strip of 0.050-gauge Monel supplies all the strength needed to hold the armature together at the terrific speeds of 24,000-25,000 rpm.

For the push rod in the jaw meshing solenoid, they need a non-magnetic, corrosion-resisting material with high hardness to stand the wham of the solenoid. "K" Monel—a Monel that can be heat treated for extra hardness—fills the bill here.

Monel and "K" Monel are two of the factors permitting Jack & Heintz to claim their starters "outlast the engine itself."

You always build in EXTRA LIFE when you use an INCO Nickel Alloy!



THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street, New York 5, N. Y.

NICKEL (INCO TRADE MARK) **ALLOYS**

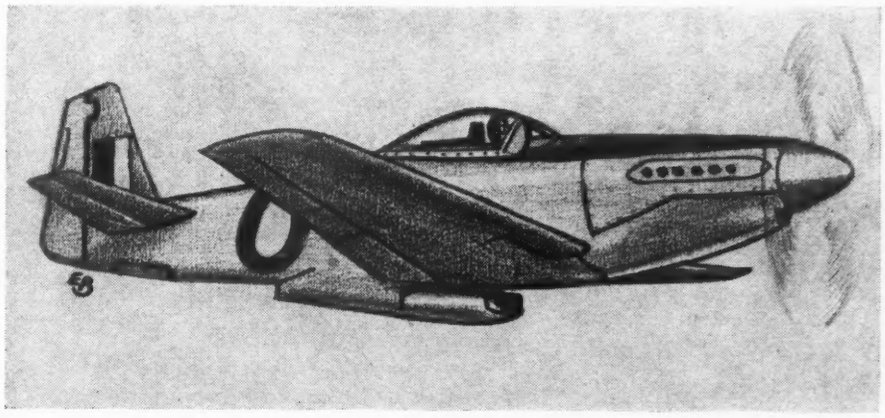
MONEL* • "K" MONEL* • "S" MONEL* • "R" MONEL*
"KR" MONEL* • INCONEL* • NICKEL • "L" NICKEL* • "Z" NICKEL*
*Reg. U. S. Pat. Off.

SPEEDY C.A.15 FIGHTER BUILT IN AUSTRALIA

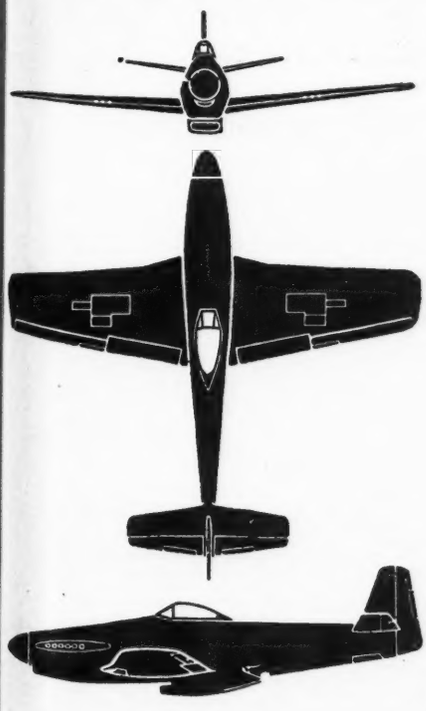
Commonwealth Aircraft debuts Mustang-like long-range combat craft said to have top speed of nearly 500 mph. Power is supplied by 2,000-hp.-plus Rolls-Royce Griffon.

FIRST WHOLLY AUSTRALIAN-designed combat plane in the over-400-mph. classification is the new C.A.15 one-place long-range escort fighter designed and produced by the Commonwealth Aircraft Corp., Melbourne. Observers have noted a decided resemblance in the new craft to the famed North American Mustang.

Of metal construction throughout, the C.A.15 is powered by a Rolls-Royce Griffon 61 engine of over 2,000 hp. turning a 4-blade constant-speed Rotol propeller having compressed wood blades. This combination is stated to give the plane a top speed approaching 500 mph. Originally, the C.A.15 was designed for a 2,100-hp. Pratt & Whitney R-2800, but since the output of this engine was almost entirely needed for American warplanes so that no steady supply could be assured, the necessary redesign for the present power plant was made.



Resemblance of Commonwealth's new C.A.15 long-range fighter to NAA Mustang is very apparent, and except for 10-deg. dihedral of horizontal tail and installation of 2,000-hp.-plus R-R Griffon engine, craft is very much similar in outline. However, C.A.15 is stated to be wholly Australian designed. Top speed is said to approach 500 mph. (AVIATION sketch)

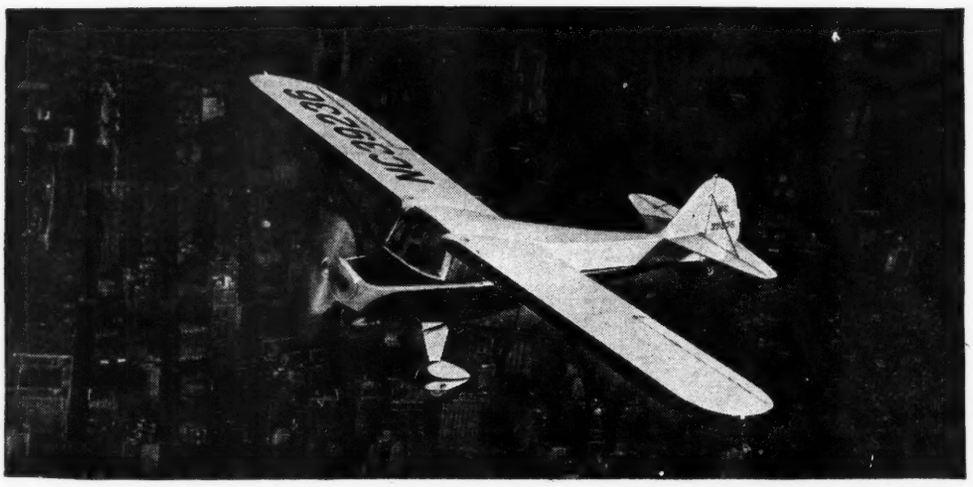


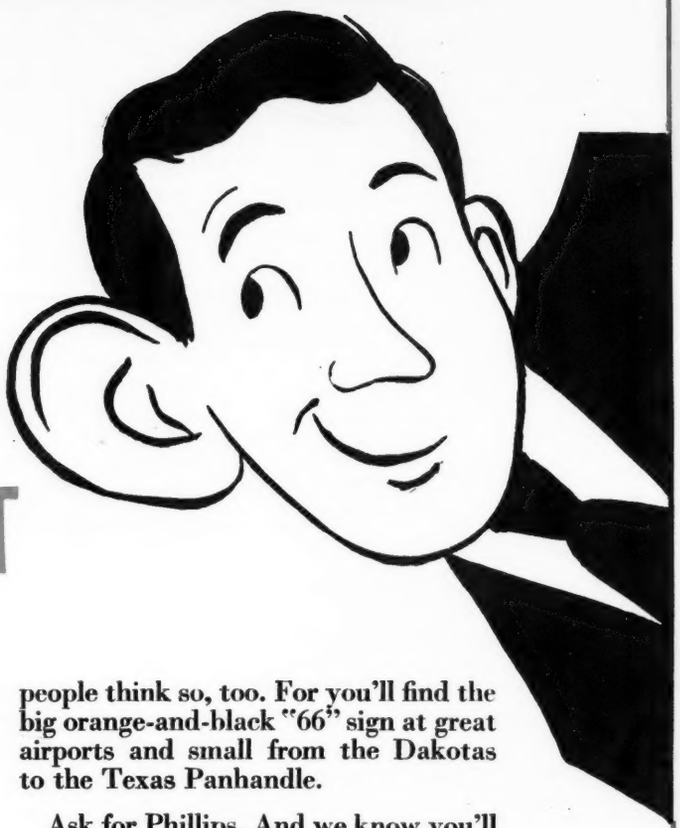
The wings, which utilize an NACA 66 laminar flow airfoil, are made in two sections mated at the center line. Maximum thickness is at 45% from the leading edge. Wing area is given as 253 sq.ft. Ailerons, fitted with a shrouded nose balance, extend over 48% of the span, are fitted with servo tabs and an electrically operated trim tab. Hydraulically actuated flaps are lowered 20 deg. when taking off, and 50 deg. when landing.

Six .50-cal. machine guns are set in the wings firing clear of the propeller arc, and in addition ten rockets, or two 500-lb. bombs, or auxiliary fuel drop tanks of 200-gal. capacity, may be carried. Main tankage consists of 220 gal. carried in the wings plus 40 gal. in the fuselage. The C.A.15's wing span and overall length are identical—36 ft.

The engine is mounted elastically on bearers of sheet-metal construction. A Morris-type single-row intercooler, and a Morris-type triple-row main radiator of 5.8 sq. ft. matrix area comprise the cooling system. Duct exit area can be varied by means of a hinged panel thermostatically controlled by engine coolant temperature. An oil heat exchanger in the intercooler system provides oil cooling. Two intakes are mounted, a small one, under the nose just behind the prop spinner, and a main ventral intake which utilizes the thrust of engine exhaust gases.

Undercarriage design affords wide tread for ease of handling on rough terrain. Main legs fold upward and inward into wing wells, with hinged panels fairing over the wheels when retracted. Tail wheel is also fully retractable.





TIP TO A MAN ABOUT TO BUY A TAYLORCRAFT

Look, nobody's happier for you than we are. You're on the brink of a new way of having fun—as well as doing business. We're all for you.

But take our advice. When it comes to fuels and lubricants for your plane —there's only one kind to use—*the very best*.

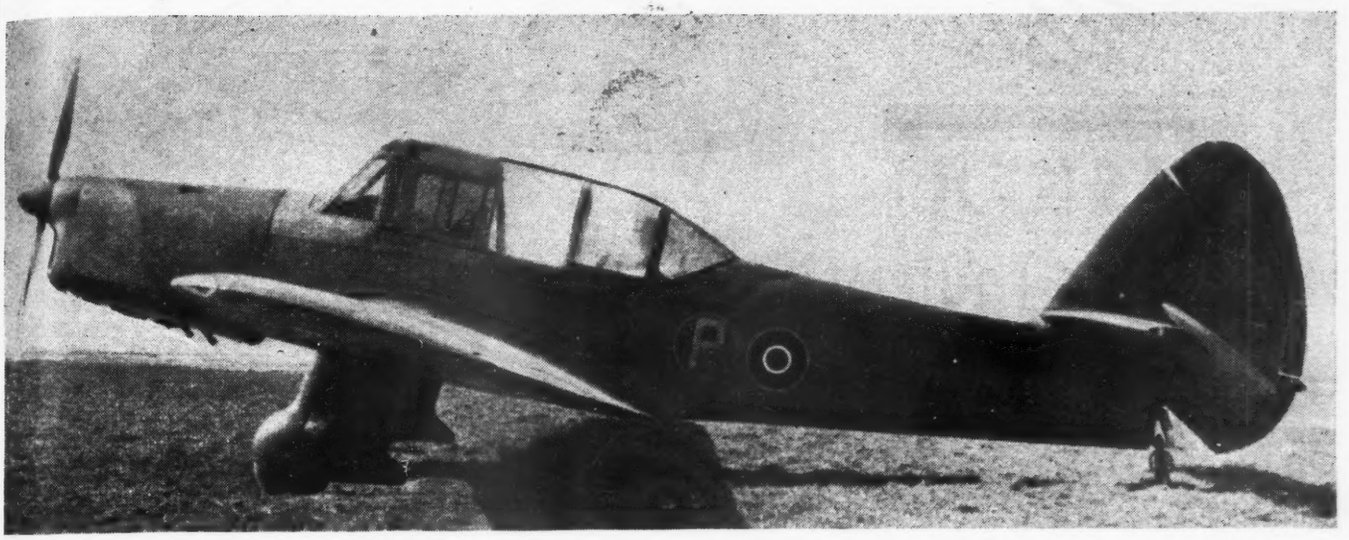
Throughout the great Middle West, we think *that* means Phillips Aviation Products. Apparently a lot of other people think so, too. For you'll find the big orange-and-black "66" sign at great airports and small from the Dakotas to the Texas Panhandle.

Ask for Phillips. And we know you'll appreciate the fact that we've gone to a great deal of trouble to speed a plentiful supply of *un-leaded* 80 octane fuel to every Phillips air-field tank. Let's get acquainted.

We'll be seeing you!

Phillips 66

AVIATION GASOLINE



Percival T.23/43 was designed to conform with a new theory of flight training. Instructor takes two students aloft, but only one has access to controls. Other tyro, seated in rear pit, merely listens in on intercom. It is believed that this method of indoctrination will better prepare novices for time when they actually take over controls.

PERCIVAL THREE-SEATER IS NEW TYPE RAF TRAINER

British firm's latest craft carries a second student who assimilates flying procedures by means of electrical intercom, but does not handle controls. Mostly of metal construction, plane has top speeds ranging from 171 mph. to 155 mph., depending on power plant.

LATEST RAF TRAINER is the Percival T.23/43, a three-placer carrying an additional cadet for the purpose of indoctrinating him in flight lore prior to taking more detailed instruction. To this purpose, an electrical intercom system is fitted so that both students can listen to the instructor.

Instructor and one student are seated side-by-side, while behind and between them sits the other trainee. The latter has no controls or instruments.

Either a 296-hp. supercharged DH Gipsy Queen 51, or 251-hp. unsupercharged DH Gipsy Queen 32 engine, can be installed, both types turning DH constant-speed two-blade props. With these power plants, respective speeds are given as follows: Maximum 171 mph., 155 mph.; cruising 160 mph., 149 mph.; and stalling 51 mph., 50.5 mph. Rates of climb are 1,070 fpm., and 890 fpm; maximum economical cruising ranges are stated to be 517 mi., and 495 mi.

Span is given as 46 ft., length 31 ft. 3 in., height 12 ft. 10½ in., wing area 305 sq. ft., and tread 144 in. Maximum wing loading is stated to be 12.6 lb./sq. ft., while power loading with the Model 51 engine is 13 lb./hp. Empty weight with Model 51 engine is 2,891 lb., with gross at 3,860 lb. Empty weight with the Model 32 engine is 2,841 lb., and gross is 3,790 lb.

Front portion of the fuselage has built-up sides and bottom, metal-covered, while the rear portion is semi-monocoque. A pair of girder assemblies are located in the lower part of the cockpit, carrying attaching lugs protruding through the skin for wing connections. Cockpit canopy is built as a complete unit, and provision is made for fitting colored filters to the transparent panels to allow simulated night flying training. Major part of the canopy can be released to facilitate emergency exit.

Each wing consists of two fabricated spars made up of extruded flanges and reinforced plate webs. Leading and trailing edges are assembled as complete units, with main ribs attached to the spars at 20-in. intervals, and the whole is metal covered. Ailerons are fabric-covered structures using D spars and formed ribs. Split-type flaps are utilized, extending from aileron to aileron, and made in three sections.

Stabilizer and fin consist of two metal spars and formed ribs, with metal covering. Elevator and rudder have a metal D spar, formed ribs, and are fabric covered. Landing gear is of the conventional fixed type, with full-swiveling self-centering tail wheel. Main gear is enclosed in streamline pants, with mudguards fitted at the rear of each wheel.

Engine is mounted on rubber blocks to steel tube bearers, and an electric starter is standard equipment. The four-piece easily detachable cowling is designed to facilitate maintenance. Wing tanks, each of 20-gal. capacity, are located at each side of the fuselage between the spars, and a 4-gal. oil tank is set in the leading edge of the left wing root.

PAN AMERICAN WORLD AIRWAYS

Uses

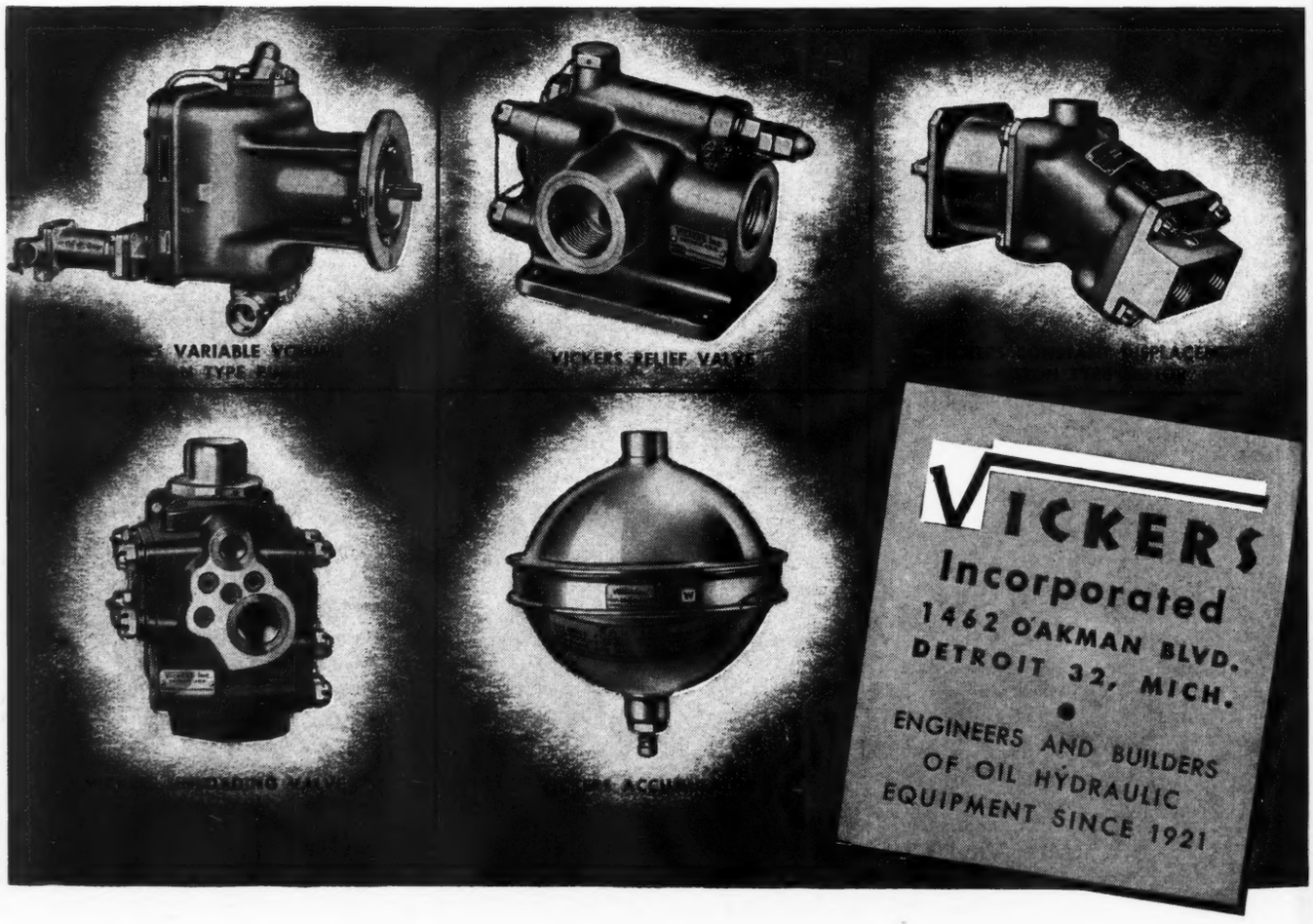
VICKERS

HYDRAULIC EQUIPMENT
ON ITS
LOCKHEED CONSTELLATION CLIPPERS

The Lockheed Constellation Clippers recently accepted by Pan American World Airways for its New York to London Service use Vickers Hydraulic Equipment.

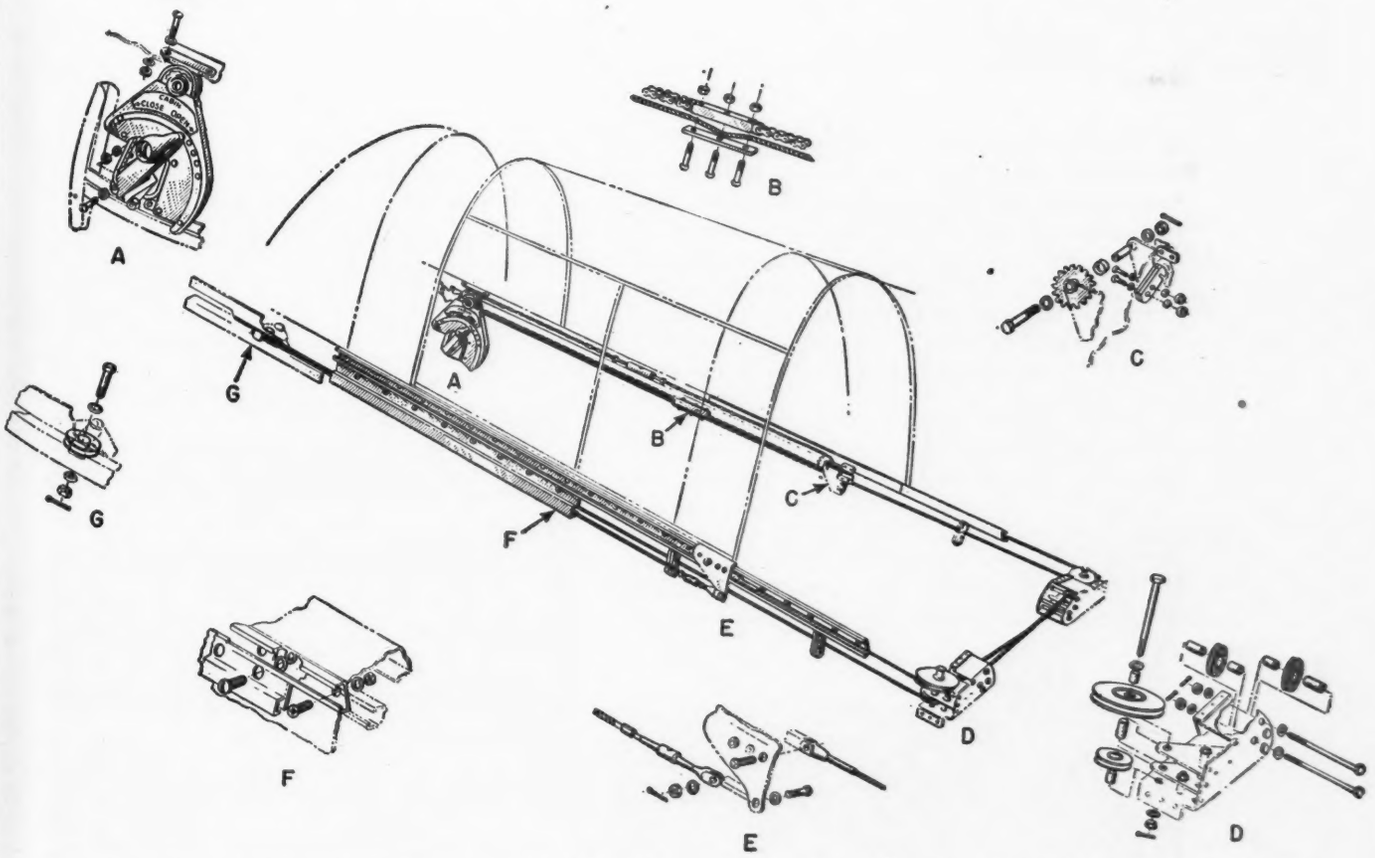
The Vickers Variable Volume Piston Type Pump automatically delivers the volume of fluid required by the main hydraulic system . . . at all times with minimum horsepower. Maximum operating pressure of this installation is 1750 psi. Vickers Hydraulic Motors are used for wing flap operation because of their high starting and running torque. Also, they can be stopped accurately to position, started instantly and stopped instantly due to the very low inertia of their moving parts. Their horsepower weight ratio is exceptionally high. The Vickers Relief Valve, Unloading Valve and Accumulator are used in the auxiliary flight control booster system.

This application is indicative of the many uses for Vickers Hydraulic Equipment on aircraft. We will be glad to help you solve your particular problems.



AVIATION'S SKETCHBOOK OF DESIGN DETAIL

Exploded view showing major components of Gruman F6F Hellcat empennage. Fin has single spar, stamped aluminum ribs, and flush-riveted metal skin which is reinforced at trailing edge to form recess into which rudder is sealed with fairprene strips. Stabilizer ribs of stamped aluminum are riveted to single shear webbed spar. Rudder and elevators are fabric-covered aluminum alloy structures. Elevators are interchangeable, right and left.



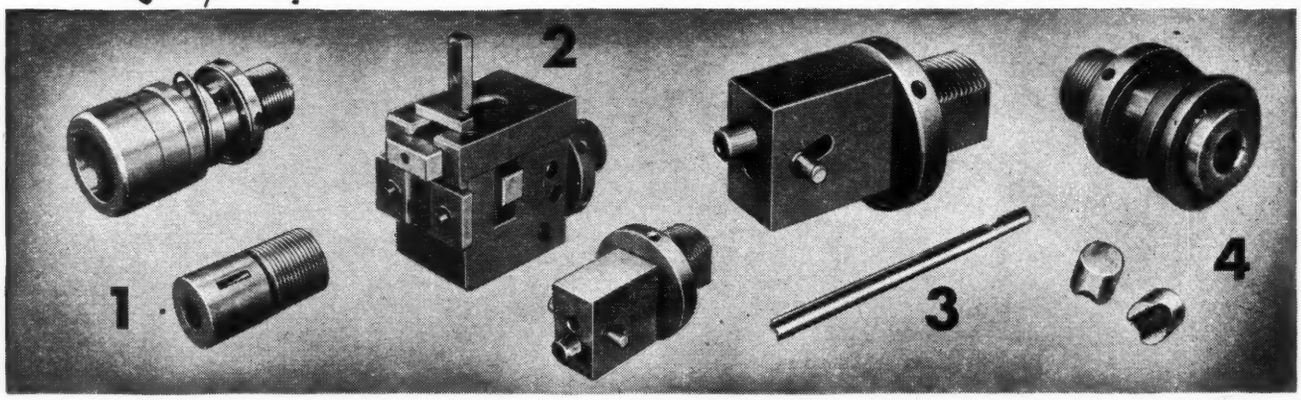
Phantom view of F6F cockpit canopy, which slides in U-track. At each corner of canopy is roller assembly which is fastened to canopy with screw shaft. Latter, in turn, is secured to canopy and safetied with locknut.

BROACHING *is One Business Where You Need* "PULL"

Be Sure You Have The Right *American* Broach Pull Head

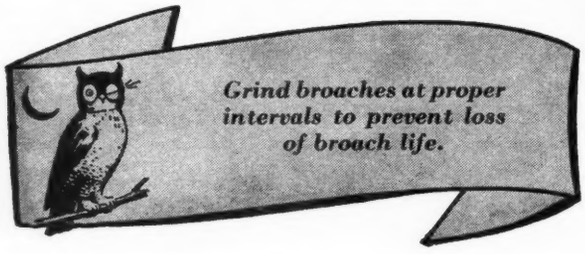
TO GIVE your broaches and broaching machines a maximum degree of operating time, you need quick-connecting broach pull heads. *American* offers a complete line of pull heads—the *right* head for every broaching operation. Each *American* model is designed with a particular purpose in mind. All are engineered and built by broaching experts.

To help you get the most from your broaching equipment, *American* has published an illustrated booklet on broach pull heads and their uses. Write for free copy. It is part of *American's* complete broaching service—machines, tools, and engineering.



Four types of *American* Broach Pull Heads are illustrated. (1) Automatic 4-Jaw Type Puller for horizontal or pull up use. A similar model, with chip shield, is made for pull down use. Standard sizes for shanks from ¼″ to 3½″ diameter. (2) Automatic Keyway Broach Pull Head for use with keyway square, rectangular, and oval broaches. Broach is rigidly held in proper alignment. Set of adapters permits using old style threaded keyway broaches with this head. (3) Automatic Pin Type Puller for use with broaches having shanks ½″ in diameter or smaller. Holds shank by means of a half-round groove cut across the pulling end. Automatically provides positive radial positioning. (4) Type "V" Quick-Change Broach Puller for use with broaches having old style threaded shank. The two-piece jaws are quickly and easily removed while head is in machine. Eliminates necessity of screwing broach into place. Replaceable jaws furnished for all sizes of threads up to 1″ diameter.

Slotted type broach pullers and ordinary threaded broach pullers, not illustrated, are also available.



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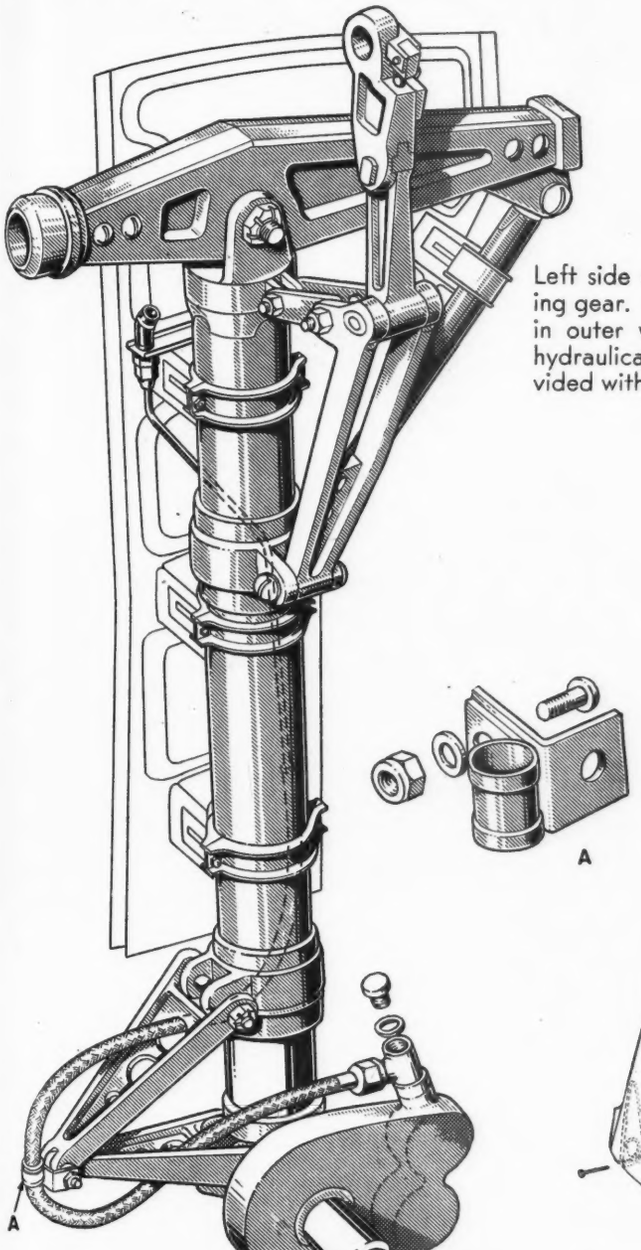
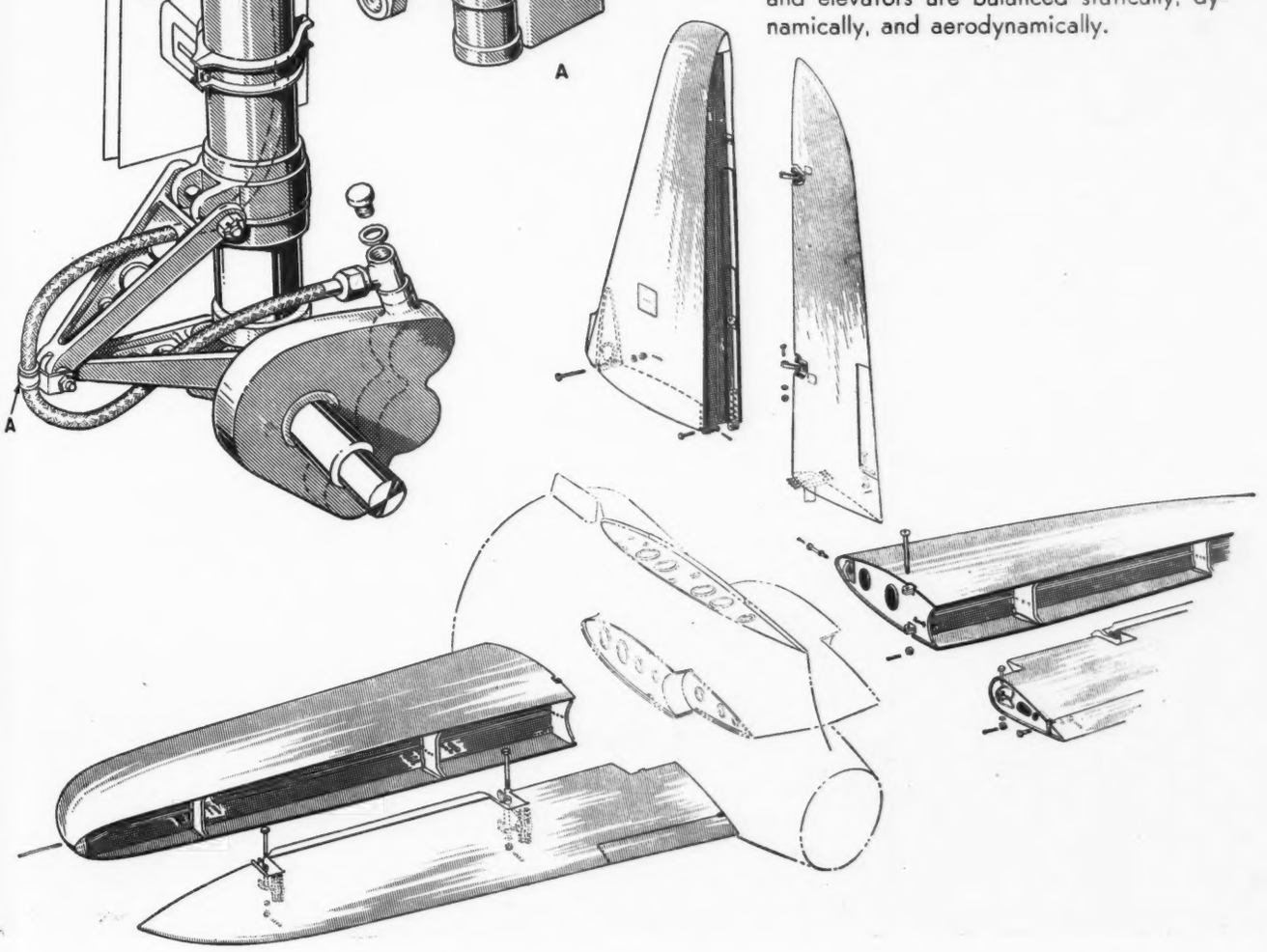


Left side of Ryan FR-1 Fireball main landing gear. Gear retracts outboard into wells in outer wing panel in 5 sec. Normally hydraulically operated, landing gear is provided with two emergency standby systems.

Exploded view of Ryan FR-1 empennage (below) which is built as complete subassembly that can be removed without necessity for rigging controls. Both rudder and elevators are balanced statically, dynamically, and aerodynamically.



The inside story of...

shoes, ships, sealing wax, even cabbages and Kings

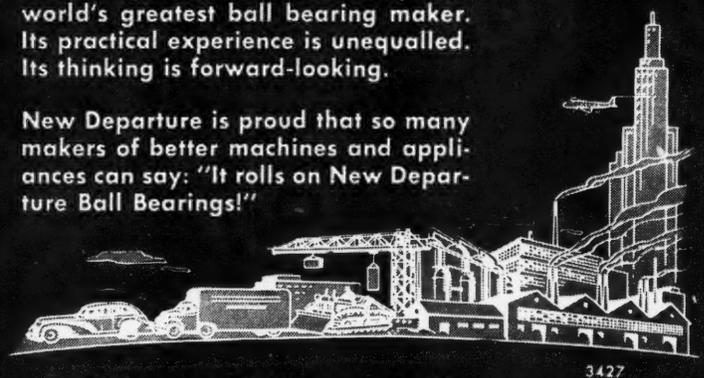
Rugged New Departure Ball Bearings carry huge loads on tough steel balls.

Almost everything used to lessen labor, do a job better, or make life roll more smoothly, has ball bearings in its system—or in its family tree.

For nothing rolls like a ball—and the *ball* bearing is uniquely fit for the higher speeds, heavier loads and greater precision of modern industry.

New Departure is deservedly the world's greatest ball bearing maker. Its practical experience is unequalled. Its thinking is forward-looking.

New Departure is proud that so many makers of better machines and appliances can say: "It rolls on New Departure Ball Bearings!"



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UNITED SERVICE MOTORS

Bearings for replacement wherever you see this sign

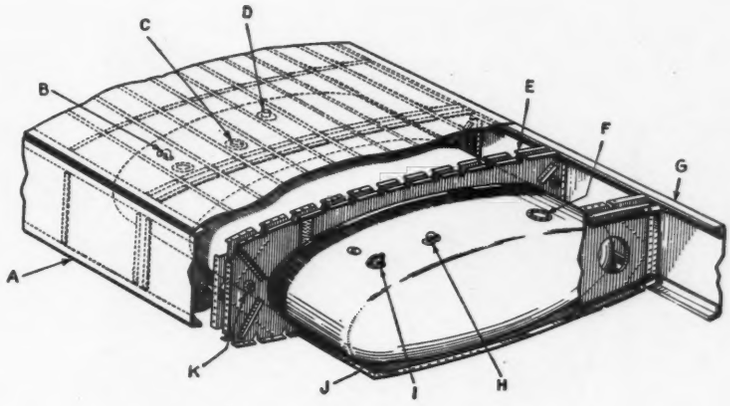
nothing rolls like a ball

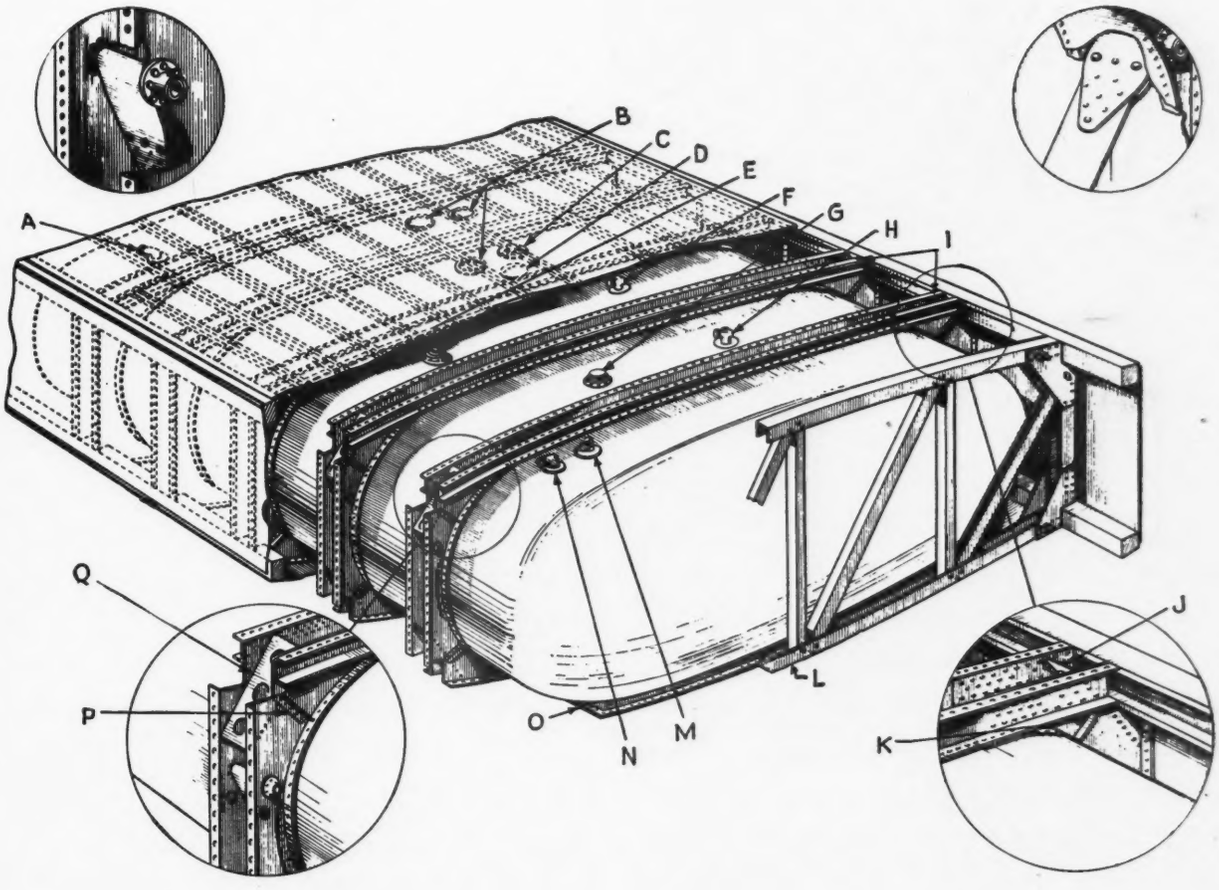
NEW DEPARTURE

BALL BEARINGS

NEW DEPARTURE • Division of General Motors • BRISTOL, CONN. • Branches in DETROIT • CHICAGO • and other Principal Cities

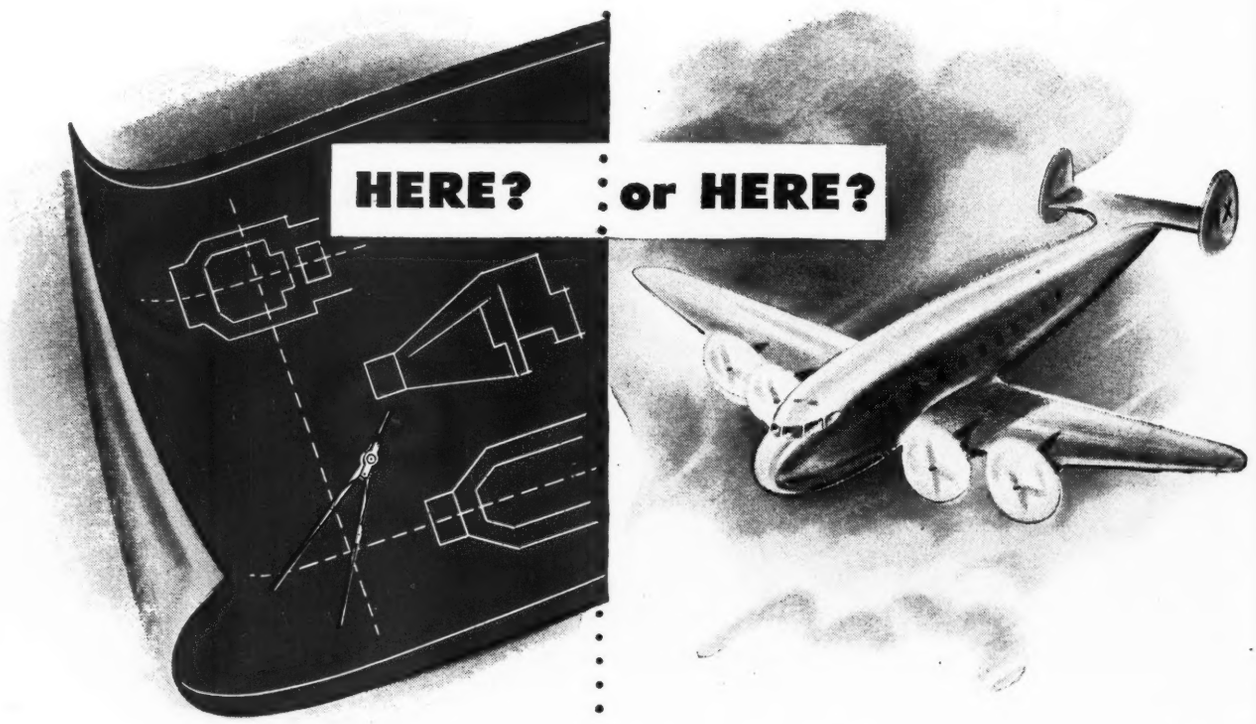
Installation of Avro Lancaster outboard fuel tank is depicted in this cutaway sketch, showing front spar (A); refueling attachment (B); fuel gage (C); fuel pump (D); tank bearer (E); inspection panel (F); rear spar (G); vent pipe attachment (H); filler cap (I); tank access door (J); and tank strap attachment (K).





Cutaway view shows method of mounting Lancaster inboard wing fuel tank, with refueling connection at (A); inspection doors in tank (B); jettison adapter (C); air valve (D); filler cap (E); fuel pump (F); fuel gage (G); pump (H); tank bearers (I)—also shown enlarged in circle at lower right with diaphragm at (J) and stiffening angle at (K)—inboard engine rib (L); air vent (M); refueling connection (N); and tank access door (O). Circled sketch at lower left is enlarged view of tank rib at front spar, with stiffening angle shown at (P) and diaphragm at (Q). Circled sketches at upper left and right depict, respectively, tank strap attachment on tank rib at front and at rear spars.

Where's the best place to kill "BUGS"



Ironing out the "bugs" brought to light in flight tests is often a costly affair. Exterminate the bugs in the blueprint stage and you save no end of trouble. It is here that Alcoa engineers can be of service.

Following the historic first flight at Kitty Hawk, North Carolina, some of the scientists at Alcoa's Aluminum Research Laboratories became aircraft design "entomologists". They set out with the men of aviation to study the requirements of aluminum for aircraft . . . build case histories and catalog every species of "bug" apt to creep into airplane specifications.

The result? Today, Alcoa can offer you more years of experience and more data on aluminum for aircraft than can be found anywhere else.

To all aircraft engineers, if you are in doubt about any characteristics of an aluminum alloy —call your nearby Alcoa sales office, or write ALUMINUM COMPANY OF AMERICA, 2182 Gulf Building, Pittsburgh 19, Pennsylvania.

ALCOA FIRST IN ALUMINUM

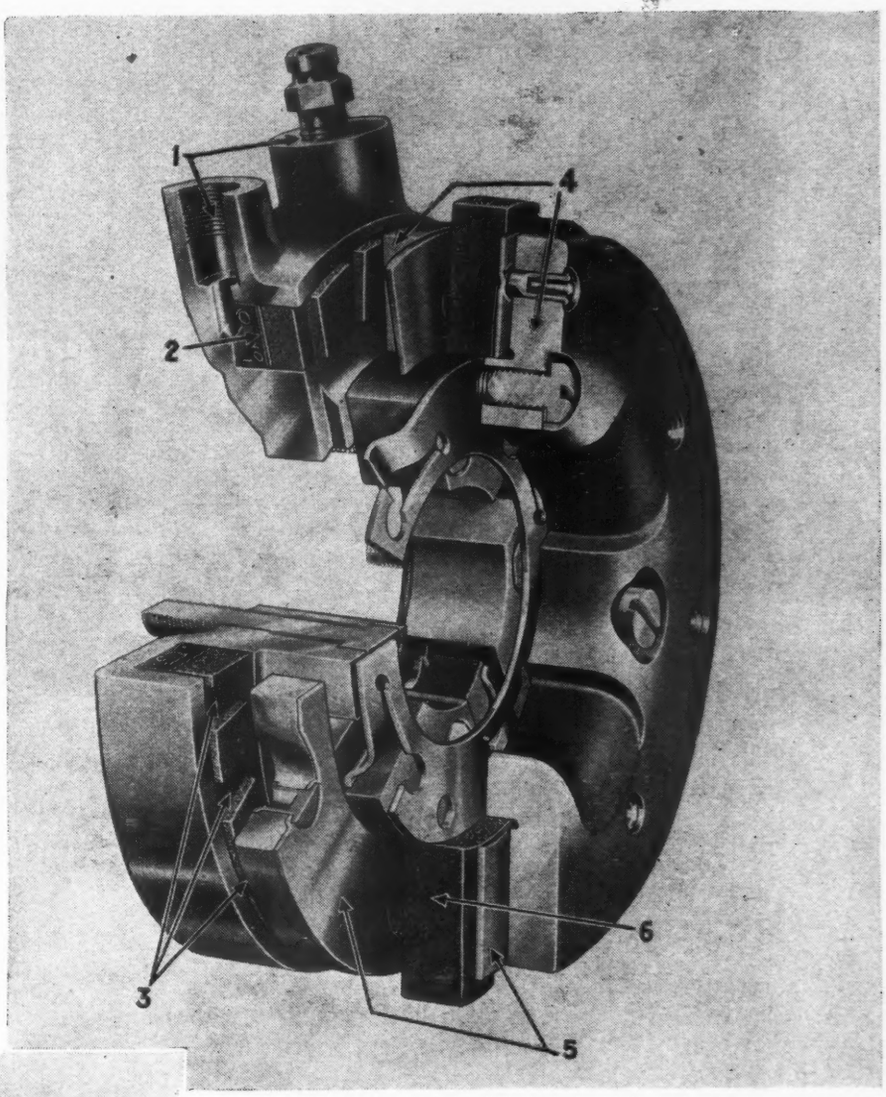
COOLING PROVISIONS STRESSED IN THIS NOVEL BRAKE UNIT

FEATURING AN INTEGRAL COOLING SYSTEM, new Firestone aircraft wheel brake is designed to minimize temperature build-up and attendant disadvantages of fade-out, wear, distortion of parts, hydraulic fluid leakage, and tire deterioration.

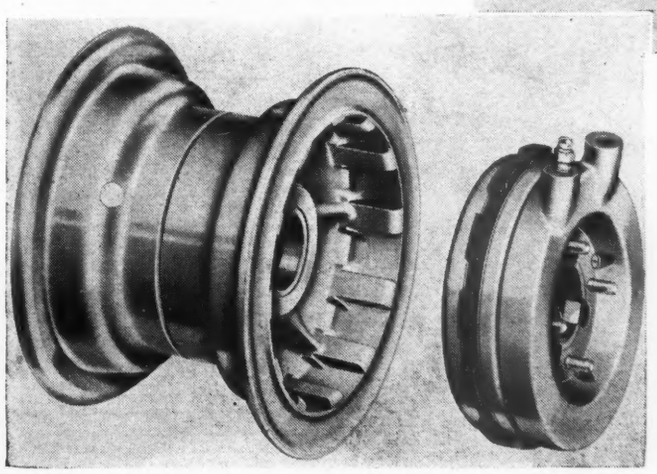
A magnesium casting, anchored to airplane torque flange, serves as a base for all major brake parts, and contains an hydraulic annular piston. Adjacent to the piston, in sequence, are (1) a stator disk mounted so as to be free to move laterally but fixed with the casting against rotation; (2) a disk of molded brake lining with lugs on outer circumference to engage with notches in wheel to cause rotation with latter; and finally (3) another stator disk. With application of hydraulic pressure, the rotating lining is squeezed between stator disks to develop frictional brake torque. And upon release of pressure, a spring installation forces stator disks apart to permit lining to rotate without drag.

Stator disks are constructed of aluminum alloy faced with a thin sheet of copper alloy. In addition to high conductivity, the aluminum alloy backing affords heat storage capacity to take peak temperatures from sudden and excessive brake applications. Low resistance to heat travel affords a flat gradient, resulting in comparatively low temperature on the outer, radiating surface for rapid overall rate of dissipation.

Advantages claimed for the brake installation include: No fading during long taxi periods, reduced cooling time between full kinetic energy stops, high reserve capacity (brake test to 200% rated capacity indicated no impairment of efficiency), and long lining life (insufficient wear to require adjustment, evidenced in laboratory test with 100 stops at 100% kinetic energy capacity).

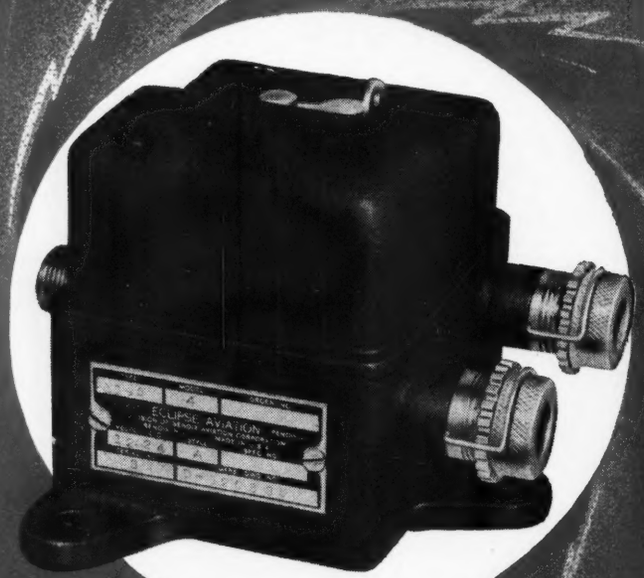


Cutaway view of new Firestone aircraft brake, revealing major components: (1) Inlet and bleeder openings for hydraulic fluid, (2) annular piston for exerting pressure on brake lining between stator disks, (3) air passages to aid in dissipation of heat radiated from brake, (4) aluminum alloy stator disks for heat storage and radiation, (5) high-thermal-conductivity copper alloy friction-facing on stator disk, and (6) molded composition lining formed with lugs on outer periphery to engage corresponding notches on wheel for rotation with latter. At center is spring element for freeing lining from contact with stator disks when hydraulic pressure is released.



View showing relation of brake unit and airplane wheel. Lining (seen between stator disks) rotates with wheel via lugs fitting in wheel recesses.

Eclipse Low tension Vibrator Coil



Provides intermittent high starting voltage with magneto protection

The Eclipse* Low Tension Vibrator Coil is an essential element of an aircraft engine starting system. It provides high magneto voltage during cranking period. An outstanding feature is the magneto protection it provides by grounding excessive current through an additional winding, in the event of frozen contacts.

Lightweight, simple and rugged in construction, it operates with a maximum current drain of 3½ amperes. Can be used in either 12 or 24 volt systems.

*REG. U. S. PAT. OFF.

Eclipse AVIATION ACCESSORIES

... REMEMBER—ECLIPSE SERVICE FOLLOWS THROUGH FROM DRAWING BOARD TO SKY

PRODUCT OF Bendix AVIATION CORPORATION

TORQUE TUBE BEARING SWAGE UTILIZED FOR LIGHT, INEXPENSIVE, QUICKLY MADE FITTING

By specifying that slowly fabricated, heavy, and expensive bolted installations be replaced with tubular steel sleeves swaged onto an aluminum alloy torque tube, Martin craft were provided with quickly fabricated, light, and economical bearings units having satisfactory torsional strength. And swaging was also used for attaching aluminum alloy sleeves as bellcrank spacers on the same assembly.

After cutting the sleeve from stock tubing, the procedure consists simply of sliding the unit over the main tube to proper location, then swaging the assembly between two steel dies on arbor or punch press, only two strokes usually being required.

Original intention in design of torque tube assembly was to provide bearing surfaces and bellcrank spacers by bolting machined steel units into tube ends. But this method was ruled out because—

(1) Taper pins would be necessary, since function of tube was to transmit torsion, with no looseness or play.

(2) Taper pin holes would require reaming on installation—a difficult operation because of space limitations, since the tube had to pass through three bearing blocks and through a series of channel sections, each containing a bellcrank.

(3) Tubing ends would have to be reamed to fit steel bearings.

(4) Detail parts would not be interchangeable after assembly had been reamed.

(5) Considerable time would be consumed to machine bearings and handle numerous components.

(6) Use of machined bearings would impose a weight penalty—steel bearing having two each pins, nuts, and washers weighing .164 lb., against steel sleeve weighing but .058 lb.

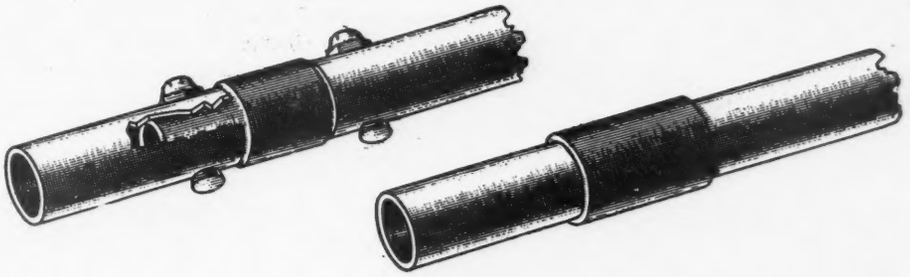
And to eliminate all other taper pins from the assembly, split type bell crank was attached to the shaft via bolt and nut. (Nut tightening torque was limited to 60 lb.-in. to prevent damage to torque tube.)

In laboratory test, strength of 4130 steel-on-24ST aluminum swage exceeded torsional strength of torque tube with free length of 6 in., a bolt through the tube holding latter in test fixture. Tube failed in torsional shear through bolt holes at 800 lb.-in. load.

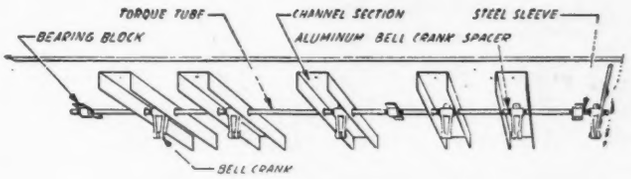
With swaged aluminum sleeve (24ST) on aluminum tube, initial slippage occurred at 400-450 lb.-in.

For satisfactory swaging, steel and aluminum alloy sleeve o.d. should be at least ¼ in. larger than tubing o.d. Sleeves should be capable of being freely slid over main tube, and provided with at least 1/16-in. material allowance to permit machining to specific diameter.

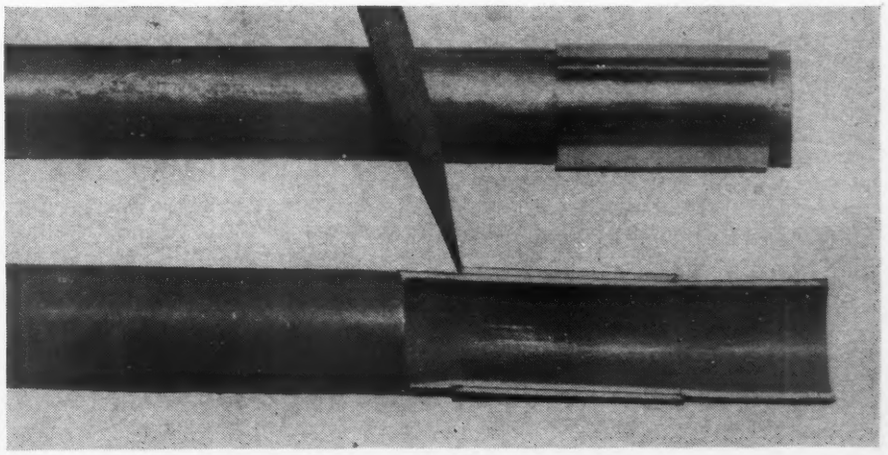
Inside corner of sleeve should be rounded (1/32-in. radius) to prevent cutting of main tube during swaging operation.



Machined steel bearing shown in sketch at left was feature of original plan for torque tube assembly. This type of bearing unit—secured by bolting—would be difficult to install, also heavy and expensive. Right: In contrast, swaged bearing installation permits rapid assembly, is light and inexpensive.



Sketch of torque-tube installation

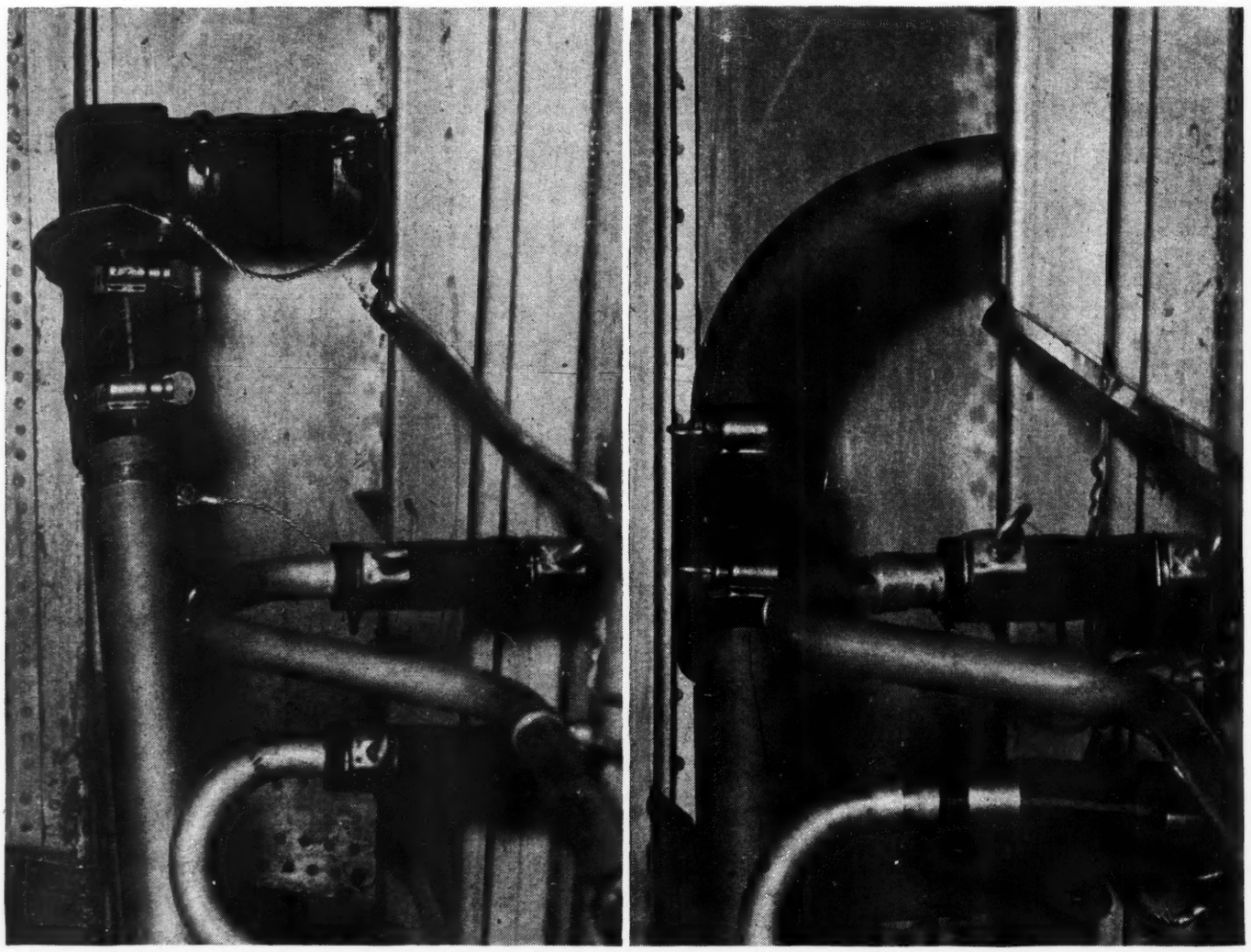


At top is seen steel sleeve swaged on tube end. In lengthwise section, showing slight decrease in tube i.d., pencil point indicates where 1/32-in. radius is required on sleeve i.d., to prevent tube damage in swaging.

LIGHTNESS AND ECONOMY COUPLED IN EMERGENCY BENT-TUBE INSTALLATION

As a result of difficulties encountered in procuring fuel line elbow fittings in time to meet JRM Mars production schedules, these parts were fabricated in the Martin shop. And with further change to right-angle elbows of 52SO tubing (1½ o.d. by .049 wall) bent on standard shop equipment, three fitting assemblies (including bonding provisions) were eliminated, manufacturing time reduced, and weight per installation cut from 1½ lb. to 6 oz. Additional advantage was improvement of flow characteristics—equivalent to elimination of over six feet of straight tubing.

Redesigned installation was cut from tubing stock and bent on 5-in. centerline radius—to conform to available tube bending equipment at the various repair bases. Beads were put on both ends and a small flange welded on for attachment to bulkhead. Entire fabrication of tubing-elbow required less than four minutes.



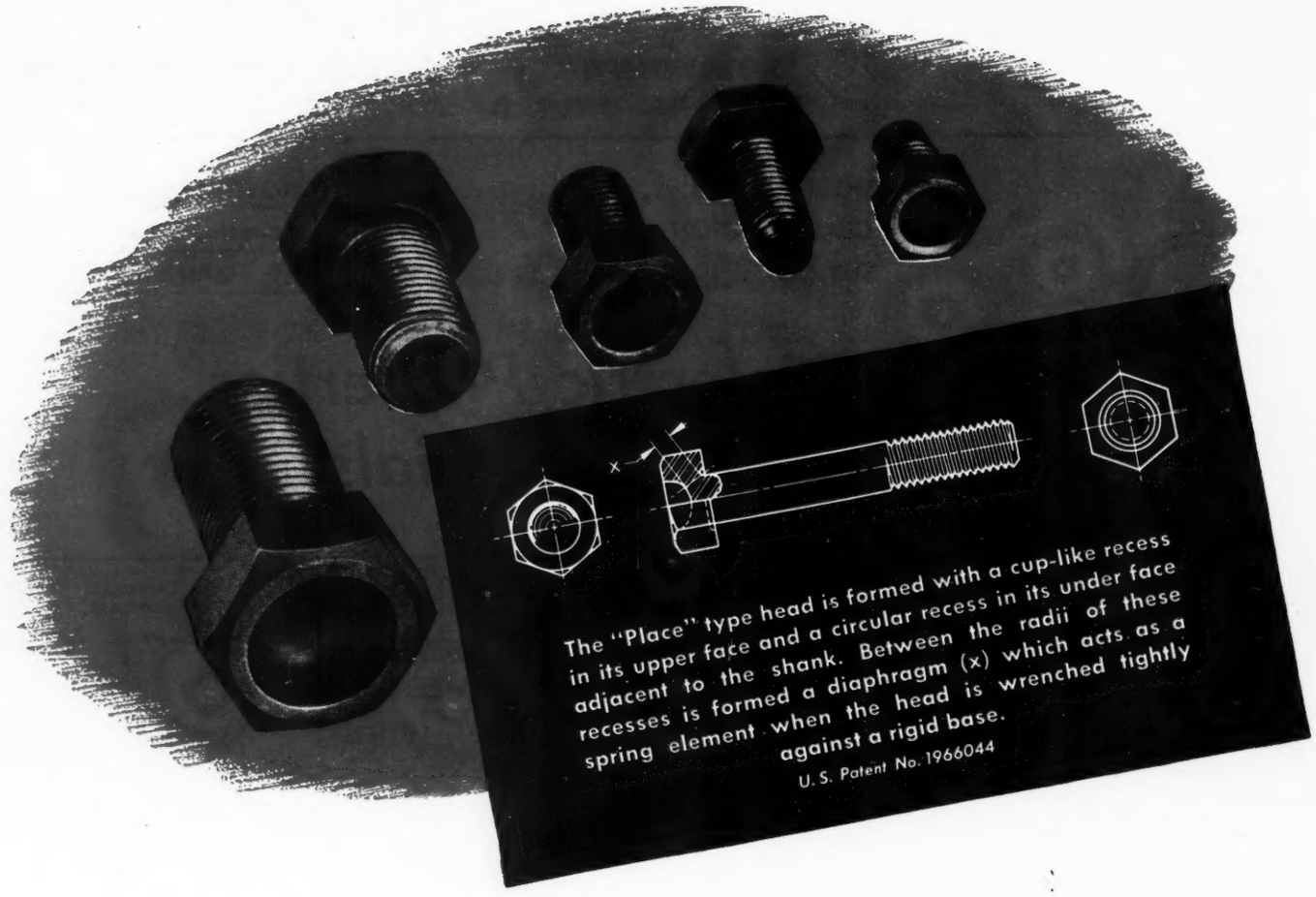
At left is seen JRM Martin Mars fuel line elbow assembly before change. In addition to bond (not visible) on tubing on other side of bulkhead, bonding plate was required for fitting. Right: New installation features bent tube joined to straight length by single hose and two clamps.

SHEET NUMBER ..... D-35 (concluded)
CLASSIFICATION ..... Induction Heating
SUB CLASSIFICATION ..... Materials

Dielectric Properties Of Materials

Materials	Density $\frac{gm}{cm^3}$	Dielectric Constant	Power Factor %
Amber	1.05	2.9	.2
Asbestos Paper (Dry)	0.5	2.7	....
Asphalt (Native)	1.005	2.7	....
Bakelite, Resin Pure	1.2	4.5	0.2
	1.3	7.0	3.0
Beeswax, Yellow	.96	3.2	1.63
	.97		
Carnauba Wax	.99		
	1.0		
Casein Plastic	1.35	6.4	5.19
Celluloid, Clear	1.35	6.8	7.4
	1.6		9.7
Cellulose, Dry	....	5	....
Cellulose, Acetate, Plastic	1.29	4.3	5.7
Ceresin Wax	0.91	2.5	.04
	.92		
Fibre (Bone) (Vulcanized)	1.3	5.	5.0
Fibre (Comm.)	1.05	5.	5.0
		7.5	
Glass, Elect.	2.2	4.1	0.5
	6.0	11.3	.7
Glass, Flint	2.9	7.0	.42
Glass, Crown	2.5		
Glass, Comm. Plate	....	7.6	.82
Glass, Pyrex, Chem. Res.	2.25	4.9	.42
Glass, Pyrex, "Radio"	....	4.4	.06
Gutta Percha	.096	4 0	....
Isolantite	....	6.1	0.18
Lava	2.5	....	....
	2.7		
Marble, Blue	....	9.4	1.22
Marble, White	2.6	9.3	4.0
	2.84		
Mastic	1.05	....	....
Mica (Muscovite)	2.6	7.3	....
	3.2		
Mica, U. S. A. Clear	2.6	6.57	0.01
	3.2	8.69	0.4
Mica, India Clear	2.6	7.07	.01
	3.2	7.90	.02
Mica Stained	2.6	5.83	.06
	3.2	9.64	8.36
Mica (Phlogopite)	2.6	5.41	.38
	3.2	6.07	7.12
Mica Reconstructed Plate	....	3.4	.13
	....	4.1	.32
Mycalex	3.3	8.0	0.2
Czokerite	0.85	2.2	....
	.95		
Paper, (Kraft) Dry	....	2.3	.5
Paraffin	.87	2.1	....
	.91		
Paper Borneo	....	....	.02
Paper Non-Crystalline	....	....	.15
Phenolic Insulation Laminated			
Nema Class X	1.3	5.5	5.0
	1.4		
Nema Class P	1.3	6.0	6.0
	1.4		

Materials	Density $\frac{gm}{cm^3}$	Dielectric Constant	Power Factor %
Nema Class XX	1.3	5.5	4.5
	1.4		
Nema Class XXX	1.3	5.0	3.5
	1.4		
Nema Class CE	1.3	5.5	5.5
	1.4		
Nema Class LE	1.3	5.0	4.5
	1.4		
Molded Wood Flour Filler	1.35	5.54	4.31
Fabric	1.37	5.0	5.0
	1.42		
Asbestos	1.75	5-15	6.0
	2.1		
Pitch, Coaltar	1.2	....	....
	1.4		
Pitch, Stearine	0.98	....	....
	1.06		
Porcelain, Dry Process	2.3	7.5	0.3
	2.5		
Porcelain, Wet Process	2.44	7.0	0.8
Pressboard (Untreated)	1.1	4.0	....
Pressboard, Oiled	1.1	....	....
Pressboard, Varnished	1.1	....	....
Quartz, Fused	2.2	4.2	.02
Rosin	1.07	2.5	
Rubber, Hard	1.12	3.0	0.6
	1.40	....	2.1
Rubber, Soft Yellow, Gum	....	2.8	0.7
Shellac	1.009	3.1	.9
Shellac Compound	1.1	....	....
	2.7		
Slate	2.6	7	
	3.3		
Soapstone	2.6	7.2	.8
	2.8		
Steatite	2.54	5.9	0.18
	2.62		
Steatite Ultra	....	5.9	0.1
Sulfur	2.0	4	....
	2.1		
Urea Resin, Plastic	1.48	....	2
	1.50		4.0
Varnish, Spar	....	5.5	3.15
Varnish, Insulating	....	4.8	5.12
Varn. Cloth Yellow	1.24	2.5	3.0
Varn. Cloth Black	1.26	2.0	2.0
Victron (Unfilled)	1.054	3	0.03
Vinyl Resin, Plastic	1.23	4.0	1.43
Vitrolex (Brown)	2.27	6.4	0.3
Wood (Air Dry) Ash	0.64	....	....
	.80		
Wood, Birch	.63	5.2	6.48
Wood, Elm	.51	....	....
	.75		
Wood, Hickory	.64	....	....
Wood, Lignum Vitae	1.33	....	....
Wood, Mahogany	0.56	....	....
	.67		
Wood, Maple, Hard	.62	4.4	3.33
	.75		
Wood, Oak	.69	3.3	3.85
	.96		
Wood, Spruce	.37		
	.55	....	....


The "Place" type head is formed with a cup-like recess in its upper face and a circular recess in its under face adjacent to the shank. Between the radii of these recesses is formed a diaphragm (x) which acts as a spring element when the head is wrenched tightly against a rigid base.
U. S. Patent No. 1966044

SELF-LOCKING "PLACE" BOLTS BY "NATIONAL"

RESIST *vibration and fatigue*

This unique bolt with a "diaphragm" head design — making it elastic and self-locking—was developed for fastening tasks that must include plenty of vibration resistance.

The axial spring tension of the "Place" type bolt head, when tightened to the desired adjustment, has effectively met critical problems of fatigue and involuntary loosening in the aircraft and automotive industries. These bolts may be used with nuts or in tapped holes, but should be used only where it is possible to tighten against a rigid seat.

National "Place" Type Aircraft Bolts are produced to conform to dimensional and material specifications for Hexagon Head Bolts AN-3 to AN-12 inclusive. They have Army and Navy approval for use on aircraft. Made of alloy steel, heat-treated to high physical properties, they are recommended for many special applications where vibration resistance is particularly important.

Write us for detailed information and prices.

National HEADED AND THREADED PRODUCTS

OTHER "NATIONAL SCREW" SPECIALTIES INCLUDE:

Drake Lock Nuts
Dynamic Lock Nuts
Hi-Shear Rivet Pins & Collars
Huglock Nuts
Laminar Flow Screws
Lok-Thred Studs
Phillips Recessed Screws
Rosán Locking System
Scrivets

THE NATIONAL SCREW & MFG. CO., CLEVELAND 4, O.

REVIEW OF PATENTS

By ELTON H. BROWN, JR.

Registered Patent Agent

Following are digests of some of the more interesting patents on aviation developments granted through the U. S. Patent Office. Mr. Brown will be happy to answer questions on patents for the reader. Address inquiries to him, care AVIATION, 330 West 42nd St., New York 18, N. Y. Printed copies of any patents listed are obtainable at a cost of 25c each, directly from U. S. Patent Office, Washington, D. C.

Automatic Pitch Control for helicopter rotor is responsive to variations in total effective driving torque, and when latter drops to less than predetermined minimum, pitch angle is assumed for autorotation. Invention is adaptable for use with tilting rotor axis or blade with varying angle of attack. —2,397,489, filed Nov. 6, '43, pat. Apr. 2, '46, E. S. Jenkins and A. F. Donovan, assignors to Curtiss-Wright Corp.

Safety Locking Device for hydraulic cylinder, designed to prevent doors closing during maintenance operations, features extended U-shaped tube adapted to be locked into position over the piston rod when latter is fully extended.—2,397,516, filed Aug. 5, '44, pat. Apr. 2, '46, G. E. Stewart, assignor to Curtiss-Wright Corp.

Propeller with variable pitch mechanism of epicycloid type incorporates electrically operated safety device supplemented by mechanical blocking means to prevent blade pitch from reaching dangerous extremes. Safety mechanism is disconnected only when full feathering or negative blade pitch is desired.—2,397,524, filed Nov. 25, '40, pat. Apr. 2, '46, N. Bellomo, vested in Alien Property Custodian.

Flying-Wing Craft is designed to provide additional takeoff lift by maintaining low pressure areas in front of propellers. Hinged wing tips are used as "boxing" units and are adapted to remain vertical until desired altitude is reached.—2,397,526, filed Jan. 12, '42, pat. Apr. 2, '46, H. Bonbright, assignor to Briggs Mfg. Co.

Airplane, designed to ascend or descend vertically, is intended to incorporate advantages of helicopter and fixed wing craft and eliminate disadvantages of each. Single propeller serves as rotor for vertical travel and as pusher airscrew in normal flight with wing angles of attack controlled by pilot in each flight condition.—2,397,632, filed Mar. 4, '41, pat. Apr. 2, '46, J. Stuart, III, assignor to General Motors Corp.

Aviator's Garment, constructed to prevent injury during high-G maneuvers, comprises support for abdominal cavity and adjacent body portions not protected by bony structure. Several sections of garment have independent adjustments, and special air bladders are provided as controlled-pressure cushions.—2,397,709, filed Nov. 1, '40, pat. Apr. 2, '46, I. R. Versoy and L. H. Loeffel, assignors to Berger Bros. Co. Subject of another patent involving same parties is acceleration belt and stockings for aviators, to afford leg protection. Provided are bladders that may be inflated by hand.—2,397,710, filed Sept. 13, '41, pat. Apr. 2, '46.

Gunsight for Dive Bombers combines telescopic unit with dive indicator so that predetermined-angle bombing attack followed by pullout may be executed without undue strain on pilot or plane.—2,397,711, filed Jan. 17, '41, pat. Apr. 2, '46, R. R. Vought.

Dive Angle Indicator, used without additional gunsight, is gravitationally actuated and traverses pilot's line of sight, enabling him to keep eye on target and simultaneously observe angle of craft's inclination.—2,397,712, filed May 15, '43, pat. Apr. 2, '46, R. R. Vought and E. R. Bergmark, latter assigning to former.

Aircraft Propulsion Apparatus utilizes rocket blast for direct operation or for operation of turbine-propeller combination. Latter is intended to provide efficient operation at low altitudes, direct rocket power being used at high speeds or altitudes.—2,397,998, filed Apr. 15, '40, pat. Apr. 9, '46, R. H. Goddard, assignor (one-half) to Guggenheim Foundation. In another invention involving same parties, transfer system is provided for changing from turbine to rocket operation.—2,397,999, filed Apr. 15, '40, pat. Apr. 9, '46, R. H. Goddard.

Aviator's Oxygen Mask for use at high altitudes provides chamber to retain sufficient quantity of exhaled gases thus maintaining mask internal temperature above freezing and preventing condensate frost formation. Mask may be quickly removed for emergencies, without removing helmet and goggles.—2,398,076, filed Apr. 20, '42, pat. Apr. 9, '46, A. H. Bulbulian.

Carburetor Anti-Icing Device comprises combustion heater to deliver hot air and combustion gases to one inlet of dual-inlet carburetor, together with means for closing either inlet while other remains open. Heater is automatically started when inlet connected to unit is open, and is inoperative when inlet is closed.—2,398,094, filed Mar. 1, '43, pat. Apr. 9, '46, S. E. Heymann, assignor to Stewart-Warner Corp.

Jet Power Plant Design features unit installation incorporating propellant containers, supply lines, and controls to permit C. G. position to remain substantially same when containers are filled or empty.—2,398,125, filed May 8, '43, pat. Apr. 9, '46, M. Summerfield and D. A. Young, assignors to Aerojet Engineering Corp.

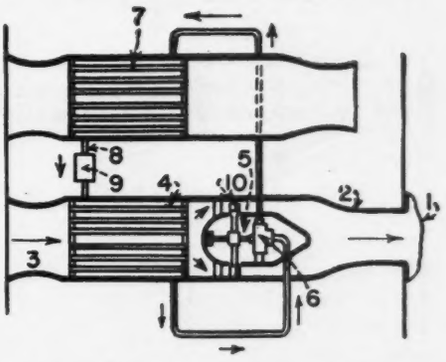
Propeller Two-Speed Transmission is designed to go into high ratio drive automatically if torque reversal occurs, regardless of ratio selected for forward drive. Thus, if transmission is set for low ratio in normal drive, it will shift to high ratio if propeller tends to drive engine, as in diving or with stalled engine. And if set for high ratio, it will remain there if torque reversal occurs.—2,398,236, W. G. Lundquist, assignor to Wright Aeronautical Corp.

Braking Control or aircraft features rudder with separable portions adapted to be hinged open to form V-shaped brake incorporating means for locking in closed position for normal flight. Principle of design is also applicable to elevators, ailerons, or dive flaps.—2,398,710, filed Oct. 6, '44, pat. Apr. 16, '46, A. M. King.

Parachute, designed to reduce opening shock, control rate of descent, and dampen oscillation, features canopy fitted with vents covered with flexible porous material. Suspension lines are so arranged as to tend to close vents under load during descent, and control means operated by 'chutist opens vents against tension of suspension lines.—2,398,795, filed Aug. 3, '44, pat. Apr. 23, '46, F. G. Manson and J. J. Maskey.

INDUSTRY PUBLICATIONS

"Landings Unlimited", is new Republic booklet describing versatility of company's Seabee amphib. . . . "Report from Aerojet" is thoroughly documented presentation of jet-assist takeoff systems developed by California concern. . . . Apprentice-Training Service, U.S. Dept. of Labor, has issued 30-page booklet entitled, "Setting Up an Apprentice Program—A Guide to Employers in Training Veterans For Skilled Trades", describing provisions necessary in such a program, as well how employer may receive approval as a qualified vets training institution. . . . "Industrial Mobilization and Design and Development of craft in Nazi Germany", being distributed by Aircraft Industries Assn., 610 Shoreham Bldg., Washington, D. C., is testimony of Albert Speer, Nazi minister of armaments and war production, given in intelligence questioning. . . . "Business Traveler" is new monthly publication containing airline and railroad travel information especially for business men. Put out by Transportation Publishing & Research Corp., 35-05 72 St., Jackson Heights, N. Y., magazine gives reservation, information, schedule listings, travel times, berth accommodations, and costs.



Air Conditioner for Aircraft, utilizing ram air for cabin cooling, derives motive power for refrigerant compressor via turbine in path of incoming air stream, turbine also serving to cool air by power absorption. In accompanying illustration, cabin (1) is fed with replenishment air through duct (2) having scoop (3) for atmospheric ram, behind which is cooler (4) followed by air-driven turbine (5) acting to take heat from replenishment air by power absorption. Cooler (4)—expansion chamber traversed by air ducts—is part of refrigerating system which also includes refrigerant compressor (6), heat absorber (7) located in independent air duct, conduit (8) and expansion valve (9). Turbine (5) has vanes (10) projecting into air passage formed around turbine shell, which are caused to rotate at high velocity to drive compressor (6).—2,398,655, W. F. Mayer, assignor to Aireseareh Mfg. Co. Div., The Garrett Corp.

Low Altitude Parachute incorporates air-charged container acting to force open pilot chute when altitude allows insufficient time for normal operation. Air container is of sufficient size to serve as life preserver in water landing.—2,399,100, filed June 30, '44, pat. Apr. 23, '46, U. H. Carr.

Landing Wheel Rotating Mechanism features automatic indicator to notify pilot when wheel has been brought up to landing speed, coupled with centrifugally operated governor to render rotating means ineffective when proper speed is reached.—2,399,218, filed Sept. 7, '43, pat. Apr. 30, '46, R. A. Felberg.

Aircraft Arresting Mechanism incorporates flexible shank portion for preventing hook from whipping when released and for yieldably holding hook in position to engage arresting cable. Hook is retractable into tunnel compartment via pilot-operated crank and cable arrangement.—2,399,244, filed Jan. 10, '38, pat. Apr. 30, '46, C. A. Nicholson.

Collapsible Float for aircraft is designed to permit more complete retraction of unit into wing than is possible with noncollapsible float structures. Float comprises rigid upper and lower portions connected with flexible watertight material, and mechanism is provided for drawing the two portions together, thus folding flexible material.—2,399,346, filed Apr. 26, '44, pat. Apr. 30, '46, T. P. Hall and B. Smith, assignors to Consolidated Vultee Aircraft Corp.

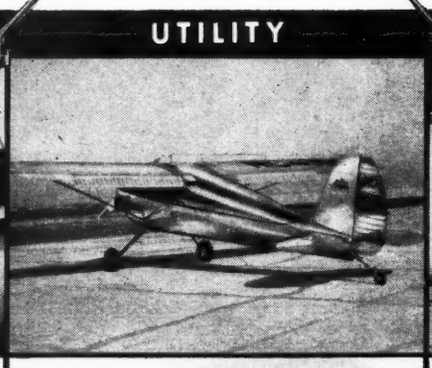
Flying Boat Base, designed to facilitate cargo and passenger handling, comprises shore dock equipped with berths for craft, also offshore breakwater for protection against heavy seas. Endless cable runs between breakwater and berth, drawing in flying boat via hooks on latter engaging cable stops.—2,399,483, filed Feb. 14, '45, pat. Apr. 30, '46, A. Gouge, assignor to Saunders-Roe Ltd.

Everyone who flies the 140 agrees . . .

CESSNA gives you *More for your Money*

COMFORT

As One Veteran Flyer Says, "The 140 is more comfortable than most big planes I've flown." Roomy, adjustable seats and relaxed leg position take care of that.

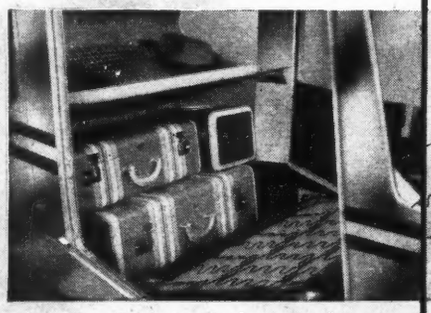


UTILITY

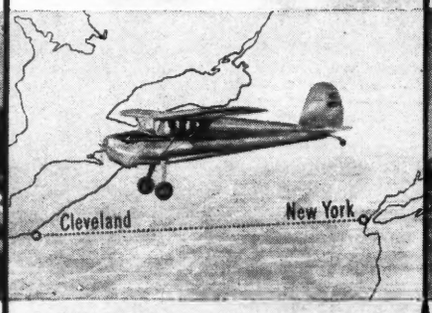
Taxi in High Winds that ground most light planes. The 140's safety gear and steerable tail wheel make it safe. And the flaps can be set for any desired angle of glide.

SAFETY

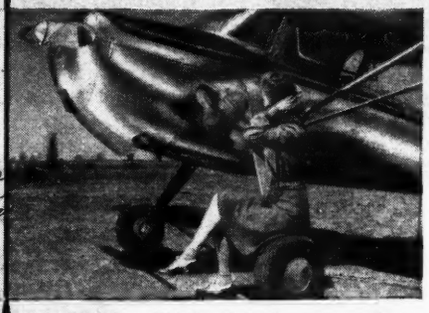
The Patented Cessna Safety Landing Gear actually combats normal ground looping tendencies. It smooths out rough fields, and has no moving parts to rattle or wear.



You Can Take Ample Luggage for two people for ten days. There's room for 80 lbs.... 2 large suitcases and 2 brief cases or 3 suitcases... plus handy utility shelf.



A 5 Hour Maximum Range assures over 4½ hours or 450 miles nonstop flying in the 140. Top speed is over 120 m. p. h. and twin wing tanks carry 25 gallons of fuel.



You'd Never Think of driving a car that didn't have good, sturdy all-metal construction. That's equally important in an airplane. Another reason why Cessna's the buy.

Cessna Alone Gives You All These *High-Priced* Features In The *Low-Priced* Field

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CESSNA AIRCRAFT COMPANY, DEPT. A, WICHITA, KANSAS

Cessna

THE PILOT'S AIRPLANE

ARMY E NAVY

SIDE SLIPS

IF YOU HEAR an underground rumbling, don't worry about earthquakes—it's probably poor old Benjamin Franklin whirling in his grave, writhing in agony at some of the inaccuracies showing up in that large, slick-paper magazine he founded. For example, the biographical piece on the Brothers Gross, in which the author refers to a "tri-motored wood-and-canvas Ford" and a Lockheed P-38 "with its twin engines, twin fuselages and twin tails."

• The pilot fell out of the plane in a state of complete exhaustion, bemoaning the fact he'd been on instruments for two solid hours. Since there wasn't a cloud in the sky, someone naturally asked, "Why instruments?"

"Gosh, I had to," the pilot replied, "I lost the railroad 300 miles back."

• The young lieutenant was more than anxious to fly home from the coastal base to his bride, but Operations refused clearance because of weather. But he begged and pleaded so hard they finally said to go ahead. He went on instruments almost immediately, and soon found himself in a storm that blanked his radio and really made him sweat trying to keep the plane right side up. He tried to get back to his home field, but no go—zero-zero. Same for several alternate stations. Finally he did manage to get to his original destination, but was so completely bushed he could barely mumble "hello dear" as he fell into bed. Just then the phone rang. He answered and, to his wife's amazement, bellowed, "how the blankety blank should I know? Ask the weather bureau."

When she asked who'd called, he wearily replied, "Aw, some dope wanted to know if the coast was clear."

• When young Lt. Henry Johnson returned from setting a new official speed record in a Lockheed P-80 Shooting Star, a reporter asked, "Did you have an official timer aboard?"

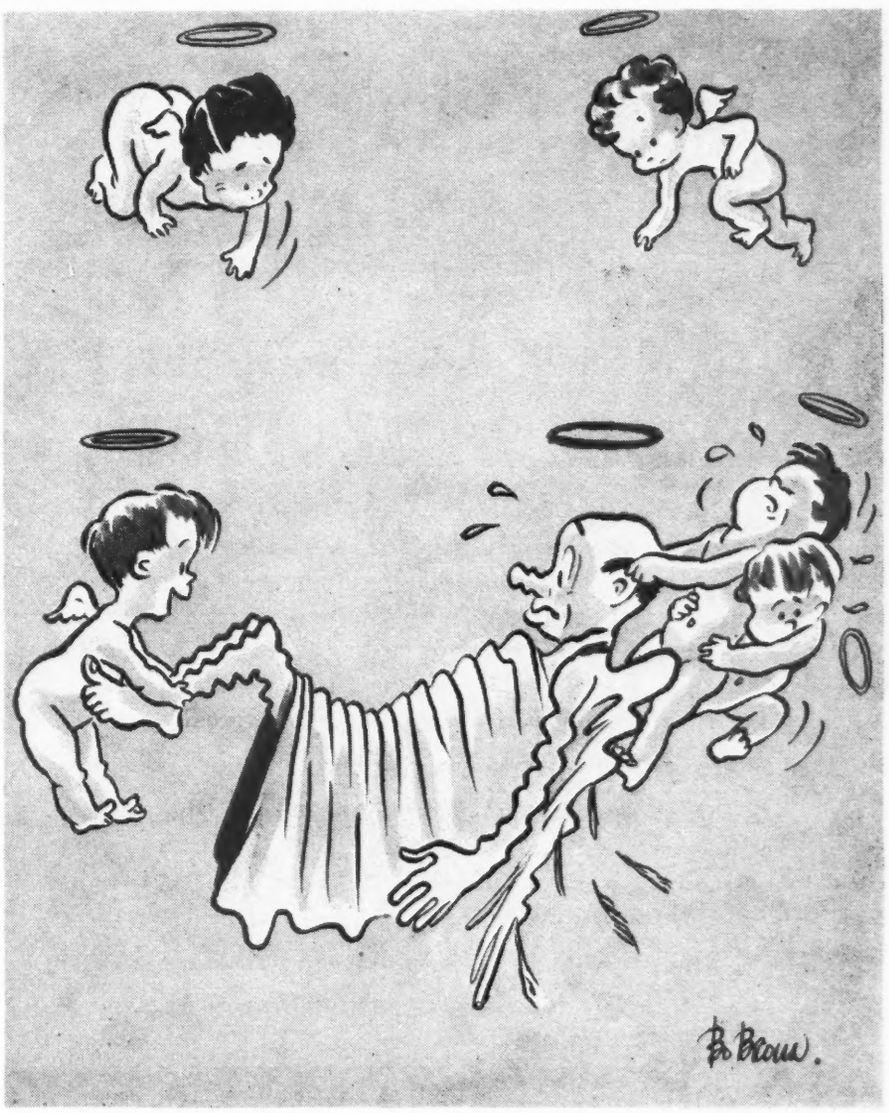
• And another of our fellow journalists asked a stopper of Capt. James M. Little, who had just cracked a whole flock of records in a Boeing B-29. Very modestly—and twice as casually—Capt. Little had explained that just as they went over the finish line at 30,000 ft. No. 4 engine started to lose oil pressure, so they feathered it. As sometimes happens, the prop came right back out—and off. As it came away it flew into No. 3 and took it off, and No. 3 airscrew in turn ripped a big gash in the fuselage. While the crew scrambled madly to get their oxygen masks on, No. 1 engine went out—and then they found themselves with no right rudder control.

But, as Capt. Little quietly said, they decided to stay with the ship and get it back to home base, which they did. Immediately a reporter popped out, "Exactly what time did you land, Captain?"

Without batting an eye, Little said, "I'm sorry, sir, I don't know. You see we were a little busy about that time."

• The area to which the boys were returning was very, very dry, beverage-wise, so they had a goodly supply aboard. But en route the weather got anything but dry. In fact it got so stinko that they were finally just about fresh out of gas and there was nothing to do but abandon ship over what they feared was rugged mountainous country. The crew chief was first into his chute—and then got busy breaking packages. And, as the first man got ready to go out the escape door, the chief calmed them all down by asking, "Which will you have, sir, scotch or bourbon?"

• Long, long years we've pounded our typewriter trying to help steer the unknowing into the elysian paths of correct prop-craft terminology. Then, f'even's sake, they invent swoosh-planes—and along comes a new vocabulary. First pupil, it seems, will have to be the maker of a vacuum cleaner gadget. "We announce," says the release, "the ROCKET jet powered vacuum cleaner."



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E. W. "Pop" Cleveland
The Landing Gear Man

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**CLECO Pneumatic Tools speed production in metal-working plants. AEROLS (the shock absorbing landing gear used so universally on aircraft) insure safe, smooth landings and take-offs. CLEVELAND Rock Drills are widely used in the mining and contracting fields.*

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THE AVIATION NEWS

BLAINE STUBBLEFIELD, Washington HERB POWELL, New York E. J. BULBAN, New York

VA Establishes Ceilings for Pilot Training; Favor Permanent Council Over Mitchell Plan

. . . Navy reveals its progress with high-speed ramjets . . . Spaatz lists nine points in air power plea . . . Announce NAR purses . . . Push cross-wind gear . . . Weigh V-2-test significance.

Veterans Administration issued Circular 119 setting up a ceiling of $20 per hour on instrument training. Some operators have been giving this training for as high as $50 per hour in two-engine airplanes, and some may have to discontinue the service, operate on a break-even basis, or change to single-engine equipment.

Circular 119 sets $11.50 for dual and $8.50 for solo, in primary trainers of less than 125 hp., for private pilots' course. For commercial course, in less than 125 hp., the same. In secondary airplanes of more than 125 hp., $18 dual and $15 solo. When training is given in both types of aircraft, at least 75% of the cost must be charged at the PT rate.

Flight instructor rating in PT of less than 125 hp. is set at $11.50 for dual, $8.00 for solo. For multi-engine rating, $45 dual or solo. Ceiling on all classroom work is 70¢ per hour. VA regional managers will try to obtain voluntary revision of long-term existing contracts. The regulations do not apply to non-profit schools.

Approval of schools is left to States, but it's stated that enrollment will not be confirmed unless it is clearly indicated that upon successful completion of course the veteran has qualifications for CAA examination. It is estimated the veteran flight training program will total about $3 billion in the next 9 yr.

Favor Permanent Council Over Mitchell Plan

W. Stuart Symington, Asst. Undersecretary of War for Air, and Gen. Carl Spaatz, AAF Chief, urged Congress to create a permanent National Aviation Council to guide and coordinate future air research and policy.

Testifying before a Senate committee on the Mitchell Bill to set up a nine-man aviation body for three months, both witnesses insisted that a permanent body is needed. Gen. Spaatz said the National Air Policy Board—the agency asked by Mitchell—could not do the job.

"The bill recommends a nine-man board to study these problems and report in three months," he said. "It is hard to believe that any nine men could do justice to the difficult problems in such a short time. Important decisions must be faced as they arise."

Symington also criticized the temporary nature of Mitchell's proposed Air Policy Board. "A continuing body is essential," he said. "It's facts must not be out of date."

Eugene E. Wilson, chairman AIA's Board, suggested that a permanent board be created which would re-examine America's aviation policy first and then keep it in tune with changing conditions.

Navy Reveals Its Progress With High-Speed Ramjets

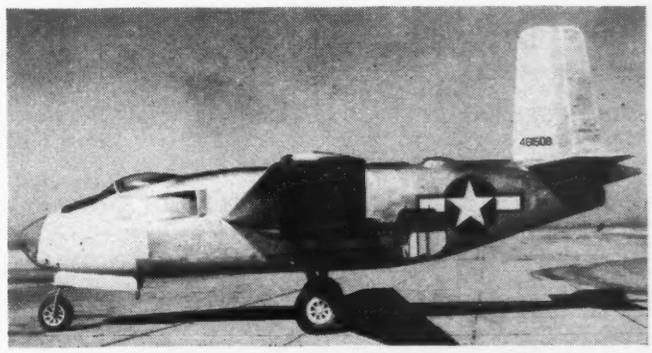
Navy Dept. discloses that it had successfully concluded the first parts of its experiments with ramjet power plants with the news that the first flight with a working model of the engine, developing 3,000 hp., reached 1,500 mph. in June of '45 in N. J.

Weighing but 70 lb., and made from "an exhaust pipe," the model was the result of collaboration between BuOrd, John Hopkins Applied Physics Lab, and more than 20 other organizations. Early use of the new engine is seen in propelling guided missiles. It's claimed that simplicity, tremendous power, light weight, and economy, make it ideal for this job. It's major disadvantage is necessity of attaining very high speeds before developing propulsion power. Rocket boosting systems are seen as one aid in overcoming this inherent handicap.

Spaatz Lists Nine Points In Air Power Plea

A strong air force, capable of backing up United Nations objectives, was strongly plumped for by AAF Comdr. Carl A. Spaatz, speaking at the American Legion's annual aerial round-up in Indianapolis.

The General stated that air power is the qualifying factor

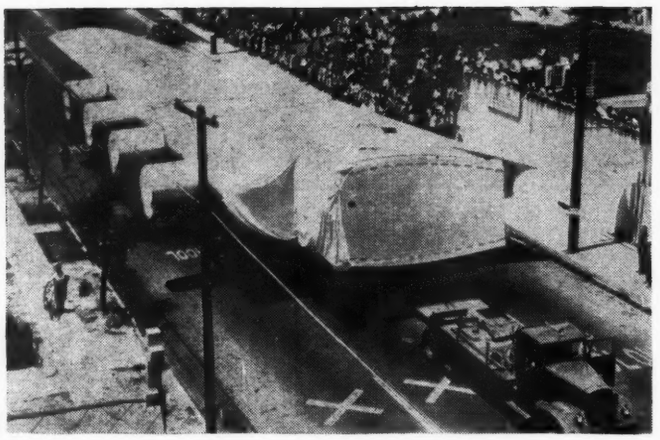


DOUGLAS XB-43—FIRST J-P BOMBER

Looking very much like company's record-breaking XB-42 Mixmaster, this XB-43 is a modification of that craft powered by two GE TG-180 axial-flow turbines of 4,000 lb. thrust each completely buried in fuselage. Intake for port engine may be noted just below bug-eye cockpit canopy, with exhaust set just under conical tail piece. Craft has 71 ft. 2 in. span and 51 ft. 6 in. length. Noteworthy is main landing gear, which folds back flush against fuselage sides. Depicted at Muroc, craft now is undergoing extensive flight testing. It's expected to do over 500 mph.

★ COMING UP ★

July 12-Aug. 11: Centurama Aviation Show, Milwaukee.
July 17-19: NAA national convention, Omaha.
July 18-19: IAS national annual summer meeting, Hotel Hollywood-Roosevelt, Los Angeles.
July 18-21: World's Fair of Aviation, Omaha.
July 19: Organization meeting Flying Farmers of Minnesota, U. of M., St. Paul.
July 20-21: Sky show and dedication of Mansfield, Ohio, airport.
July 26-27: NAA Joint Private Flying Conference, Milwaukee.
July 29-30: NAA Joint Air Youth Training Conference, Milwaukee.
July 30: IATA European-South American route conference, Paris.
Aug. 1-2: The National Flying Farmers Assn. First Annual convention & Oklahoma Flying Farmers Conference, Oklahoma A & M College, Stillwater, Okla.
Aug. 2-4: Observance of 20th anniversary of air passenger service, Grand Rapids, Mich.
Aug. 15-16: IAS Annual Summer Meeting, Los Angeles.
Aug. 17-18: Port Columbus, Ohio, Air Show.
Aug. 21-28: First World Congress on Air Age Education, International House, New York City.
Aug. 22-24: SAE National West Coast Transportation & Maintenance Meeting, New Washington Hotel, Seattle.
Aug. 24-25: Denver International Air Show, Denver.
Aug. 30-Sept. 2: National Air Races, Cleveland.
Aug. 30-Sept. 2: 15th National Championship Model Airplane Contest, sponsored by Wichita Kiwanis Club and Wichita YMCA, Wichita, Kan.
Aug. 30-Sept.7: First postwar Canadian air show, sponsored by NAA of Canada, DeHavilland Airport, Toronto.
Sept. 4-12: Air Fair, sponsored by Aviation Council of Metropolitan St. Louis, Inc.
Sept. 5-15: St. Louis, Mo., Aviation Week.
Sept. 17: IATA Western Traffic Conference, Rio de Janeiro, Brazil.
Oct. 3-5: SAE National Aeronautic Meeting & Aircraft Engineering Display, Biltmore Hotel, Los Angeles.
Oct. 4-12: National Air Show, Cleveland.
Oct. 14-17: National Aviation Clinic, Oklahoma City.
Oct. 16-17: SAE National Transportation & Maintenance Meeting Hotel Knickerbocker, Chicago.
Oct. 23-25: Second Annual Arizona Aviation Conference, Phoenix.
Oct. 24: IAS Air Transport Meeting, Statler Hotel, Washington, D. C.
Oct. 29: Annual meeting International Air Transport Association, Cairo, Egypt.
Nov. 1946: International Aeronautic Exhibition, Paris, France.
Nov. 7-8: SAE National Fuels & Lubricants Meeting, Mayo Hotel, Tulsa.
Nov. 15-24: National Aircraft Show (eastern), Cleveland Municipal Airport.
Dec. 2-4: SAE National Air Transport Engineering Meeting, Edgewater Beach Hotel, Chicago.
Dec. 12-15: International Aviation Celebration, El Paso, Tex., auspices Chamber of Commerce.
Dec. 17: IAS Wright Brothers Lecture, N. Y. C.



HUGHES CONDUCTS OPERATION OVERLAND

Wings of Howard Hughes' giant H-4 all-wood 400,000-lb. gross-wt. flying boat start trek from factory at Culver City to graving dock in Long Beach, Cal., for assembly with fuselage. Craft is to be powered by eight P&W Wasp Majors of 3,500 hp. each. (Press Assn. photo)

of any country's fitness in the new era, also said he thought the AAF's efficiency was gradually being brought to a high level under the policy statement made in Mar. '46.

The most pressing objectives of an air force in being were given by the General as follows: Supporting the U.N. with adequate and effective air strength; preserving the peace until an international body succeeds in operating; avoiding war by insuring the peace; alertly defending our Arctic frontier; continuing the effectiveness of our air-land-sea team; stimulating continuous program of research and development; providing for a quick expansion of the aviation industry; alertly avoiding another Pearl Harbor; and furthering intelligent public understanding of air power.

Announce NAR Purses

Plenty of cash as well as glory will go to National Air Race winners during four-day classic at Cleveland starting Aug. 30, according to official announcement. A total of $109,500 will be distributed. Last race in '39 gave $85,000 to champion pilots.

Breakdown reveals following awards: Bendix Race $25,000 total; Thompson Trophy Race $39,500; the Sesquicentennial Closed Course Speed Event $15,000; Women's Race $5,000; the Weatherhead Service Jet Speed Dashes $25,000 (to Army and Navy Relief Societies).

A total of $29,500 could be garnered by a single pilot if he won Bendix and Thompson events, and broke old 283-mph. record in latter event.

Push Cross-Wind Gear

Experiments with swivel-wheel landing gears, for greater safety in cross-wind landings, are well under way, with CAA having received $150,000 from Congress to allocate to various manufacturers. Fairchild is now flight testing its version of the gear on a PT-19, Goodyear is working on a towing rig for ground testing, and it's said that a contract with Bellanca is under consideration.

Although some of the big plane builders have evinced interest in the work, they have found themselves too busy to take it up at this time. CAA is convinced that successful development of the idea would cut airport costs by millions of dollars, by obviating need for some of the number of runways now necessary.

Weight V-2-Test Significance

Army's recent launching of the German V-2 rocket and its own much smaller WAC Corporal rocket, at White Sands, N. M., is significant in more ways than one. First, the V-2 is, of course, obsolete; the Army was merely practicing at tracking it with radar. Second, the stunt was handled, not by AAF, but by Ordnance, which claims that rockets are artillery, not aviation. Air Forces got in on the show at the last minute.

A long and bitter struggle could develop between AAF and ground services for control of rocket warfare. It has been pointed out that if rockets develop as a major weapon, and if they are controlled by ground forces, military aviation might be specifically curtailed in future.

However, cautious observers feel that many rockets of smaller size will always be flown, and military aviation will have a large function in air transport and in some categories of combat, regardless of guided missiles, for a long time to come. Navy and Army are working on missiles far more advanced than any yet revealed.

★ SPOT CHECKING ★

Post Office Dept. will use helicopters within a year, officials state. Dept. is sponsoring two-week test of 'copter service in Los Angeles area, and regular service in N. Y., Chicago, Boston, Detroit, Philadelphia, and Los Angeles is expected to start late this year or beginning of '47.

Personal plane market survey by Aeronca indicates that 40% of current potential purchasers are middle-class householders, with wives and children, who will use planes chiefly for pleasure. More than one-third will use them for business; about 55% of market already knows how to fly; only 3 out of 100 customers are women; those willing to pay cash and those who wish to make time payments are about equally divided; best customers are in 18-30 age group; slightly more than half prefer side-by-side seating, while one-quarter prefer tandem seating, and rest aren't particular; and about 60% of planes sold would be bought in rural areas.

A fund to provide 8 hr. of dual flight instruction to highest ranking students in eight Kansas City public high schools has been established by several K.C. firms.

Downward adjustment in prices for several types of surplus warplanes has gone into effect. New listings put Beech AT-11 at $15,000, $12,500, $10,000, and $7,500, depending on conditions; Boeing PTs are from $2,400 to $590; Timm N2T is $1,490; and Vultee BT-13s are $450.

Eventual military use of liquid-fuel rocket projectiles fired from aircraft and guided or homed on aerial and ground targets is foreseen by Roy Healy, ATSC rocket engineer. He states that AAF is now developing new projectiles and low-drag retractable launching mechanisms for use on all types of military planes.

CAA unveiled first radar-equipped control tower for civilian flying at Indianapolis, employing a console screen to give controller a plan-picture of all aircraft within 30 mi. of airport. Basic radar equipment used is known as Navy SG. It's said to have no blind spots.

Nylon cloth .020-in. thick is being used to fabricate fuel tanks for Boeing Stratocruisers, with a saving of about 3,700 lb. over former tanks. Covering of two-ply glass cloth protects nylon from metal surfaces. It's stated new tanks can be refueled in 10 min.

Convair is working on a new two-place pusher monoplane, designed by J. M. Gwinn, Jr. Craft is said to have engine buried in cabin with power shafted to a three-blade prop located behind tail surfaces.

Fee for commercial and airline transport pilot physical exams has been hiked from $6 to $15, contended to have been necessary to obtain more proficient type of medical examiners. But the United Pilots & Mechanics Assn. vigorously protests raise, claiming it was not justified, that it will not increase air safety, and that will not improve exams' effectiveness.

CAA's plan to acquire a stock of parts and do its own maintenance on its surplus fleet of 231 planes ended in a compromise. House of Representatives clipped $800,000 from CAA's maintenance request, and authorized use of one base instead of three. CAA must contract for repairs of over $100 per plane. It was pointed out that Army, Navy, and Post Office maintain own equipment, but aviation groups contended that in this case, Government was competing with private business.

New Army regulation makes military field available to civilian pilots under certain conditions. Civilian planes on Government business, and planes not operated for profit may land with C. O.'s authorization. Fields leased by AAF may be used only with War Dept. permit. Emergency sales of fuel and parts to enable stricken planes to reach nearest commercial field will be permitted, and emergency storage may be provided if available.

★ CANADIAN NOTES ★

By James Montagnes

Manufacturing: DeHavilland of Toronto, has started production of a new two-place primary trainer, called the Chipmunk, to replace prewar Moth. Craft is all-metal low-wing monoplane, equipped with a 140-hp. DH Gypsy engine, Plexiglas-covered cockpit, and conventional landing gear. It's said to be 40 mph. faster than Moth. . . . A. V. Roe, Toronto, has government contract for design and development of gas turbine engines and has taken over work of government's Turbo Research, Ltd. Company is overhauling TCA Lancastrian type trans-Atlantic transports after 2,000 flying hours. . . . Tom Smith, formerly with Convair's Stinson Div., has been named general manager of Fleet Aircraft, Fort Erie, Ont.

National Research Laboratories' 47-ft. tailess two-place flying wing glider, is now undergoing RCAF tests at Edmonton. . . . Air Transport Board members, Air Vice Marshal Alan Ferier and J. P. R. Vachon, are examining airlines and expansion needs in West Canada and in North Canada west of Great Lakes. . . . Ottawa will spend, in 1946-47 fiscal year, $8,000,000 on new airports, $4,000,000 on maintenance and improvements of existing airports, and $11,500,000 on administration of air services and regulations.

By F. H. Fullerton

Prince George, B. C., is now head office of Central British Columbia Airways, and operation bases have been set up there and at Fort St. James. Having received license from Air Transport Board, company will operate charter service to all points in central and northern B. C. W. E. Gilbert is president, and his associate is Russ Baker, well-known bush pilot formerly in charge of CPA's operating base at Fort St. James.

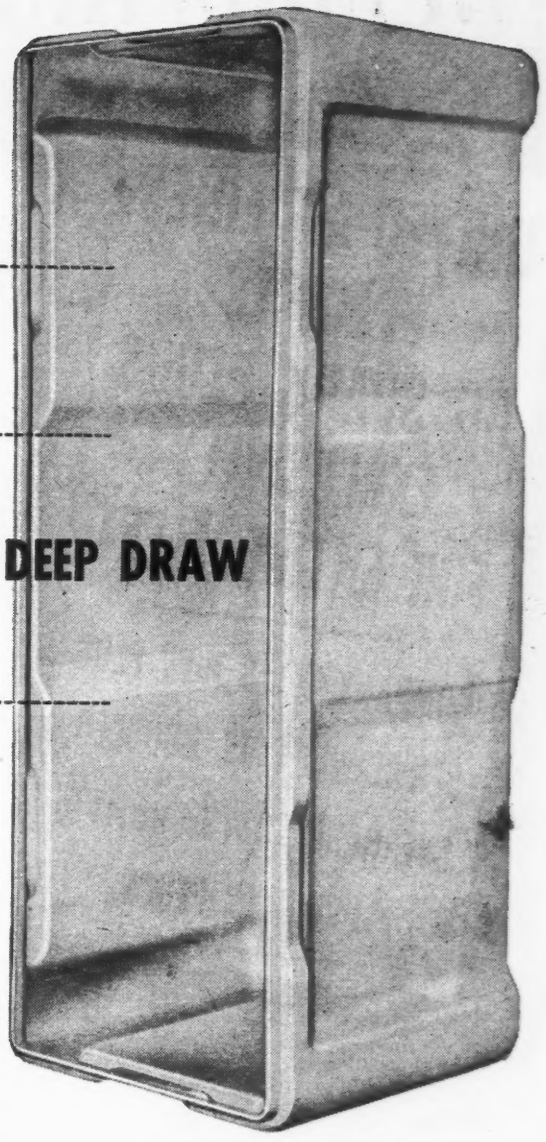
★ PLANES AT WORK ★

Fitted as a flying office, a twin-engine Cessna is being used by organizers and representatives of International Assn. of Machinists to carry on organization work throughout U.S. IAM plans to purchase another craft this year.

Aerial photography is to be used by U.S. Bureau of Reclamation in speeding up design and planning work on seven irrigation projects in Missouri River Basin.

Stocking a store entirely by means of air freight is new wrinkle tried by Air Cargo Transport, flying tons of women's wear from N.Y.C. to Pasadena, Cal. Store officials say

FINAL, ACCURATE DIMENSIONS IN 1 DEEP DRAW



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1. You can effect greater deformation without danger of fracture. Reductions up to 65% in one operation are common.
2. Less power is needed because yield strength is lowered in this temperature range.
3. Time and money are saved through elimination of interstage annealing and multiple press operations.
4. Tool costs are materially reduced because no interstage dies are needed.
5. Springback may be eliminated, so that the part can be drawn to a final fit in one stroke.

Consider what this can mean in terms of production speed and economy. Then add to that the outstanding feature of magnesium alloys—their feather-light weight, their extremely high ratio of strength to weight—and you see how better airplanes, better truck and bus bodies can be made at a substantial saving in the cost of time, labor and tools.

Revere light metal products include magnesium sheet and plate, rod and bar, tube, extruded shapes, and forgings in all standard wrought alloys, as well as aluminum alloy tube, extruded shapes and forgings. A Revere Technical Advisor will gladly consult with you about the application of these products to your business. Get in touch with Revere.

Weighing only 5 lbs., this box 29" long, 11" wide and 10¾" deep was made of Revere magnesium alloy 0.081" sheet by Brooks and Perkins, manufacturing engineers, 2457 Woodward Avenue, Detroit, Mich. Produced in *one* draw on a 200-ton hydraulic press at a temperature of 550°F. An additional operation formed the shoulder at the top to receive the lid. Made to carry military rockets, these deep-drawn magnesium boxes suggest how readily magnesium can be used to lighten the weight of bus and truck body parts as well as numberless other products.

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June 3, 1946

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Gentlemen:

You will be interested to know that United Air Lines is specifying BG spark plugs exclusively for its entire fleet -- including the new four-engined, 52-passenger 5-mile-a-minute Mainliner 300's, the first real post-war transport plane designed and built after the war for airline operation.

The decision to use only BG spark plugs was the result of exhaustive tests made by our maintenance engineers. For one thing, it was determined that under actual coast-to-coast operating conditions the point-erosion for the RB-19-R platinum-tipped BG plug was only .004 to .005 of an inch for a 300-hour period. Also, it was noted that there was a minimum of gas leakage through the ceramic core of BG plugs, a feature which is important in getting maximum efficiency of operation.

Not only has the service life of our spark plugs been doubled but overhaul costs have been reduced from 8 cents to only 4.7 cents per unit with the use of BG plugs.

With United operating 162,000 miles daily or the equivalent of six and one-half times around the world every day, you can readily understand why we consider dependability, long life and economy so important. All these features are present in BG's.

Yours very truly,

W. C. Mentzer

W. C. Mentzer
Director of Engineering

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Another striking example of BG economy, efficiency, dependability and long life from one of the world's largest air lines. BG ceramic-insulated ...plugs are the result ... twenty-five years ... and service to air ... operation.

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THE BG CORPORATION

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MANUFACTURERS OF BOTH CERAMIC-INSULATED AND MICA-INSULATED AVIATION SPARK PLUGS

bulk of their shipping henceforth will be by air . . . . ACT is also flying other clothing for N.Y. makers to West Coast, eliminating need for packaging goods.

First racehorses to be flown coast-to-coast recently were transported from N.Y. to Inglewood aboard an American Air Cargo Express DC-3 equipped with tandem box stalls. It's claimed time saved enabled horses to get over 'shipping fever", also for leg stiffness to be worked out.

To speed his aerial news photo service, Maurice Fitzgerald, Buffalo, had AAA install pickup equipment on his Piper Cub, eliminating need of landing in course of hurrying photos to papers.

Shipment of over 1,000 telephones was recently made by Western Electric from Chicago to Atlanta, Ga., aboard a Delta Air Lines' DC-4.

Eight "cover" girls and a shipment of exclusive gowns was flown from N.Y. to Brazil to take part in a fashion show in Rio de Janiero.

Royal Canadian Mounted Police took delivery on two Beech 18S planes for use in transporting officials, prisoners, witnesses, and evidence.

Extensive pest control project in Yakima Valley, Wash., is to be undertaken with aid of a specially equipped Bell 47 'copter fitted with spraying and dusting equipment. Experiment is expected to prove suitability of rotary wing craft for this work.

★ CALLING NAMES ★

G. G. Brooder has been appointed asst. to pres. of WAL, with hq. in Denver.

Gordon L. Gilmore is now director of TWA's N. Y. news bureau.

Douglas appointments: **O. L. Bowers** has been made dir. of ind. rel. at Long Beach, succeeding **E. A. Puffer** who transferred to same post at Santa Monica; **Col. Francis S. Gabreski,** celebrated AAF Ace, has been named asst. to v.-p. in charge of foreign sales.

Claude D. Richardson, Jr., has been appointed director of engineering for TACA, with hq. in Miami.

Col. Warren E. Carey is now chief of Master Airport Planning Staff of State of Cal. Reconstruction & Reemployment Commission.

American Rocket Society elections: **Lovell Lawrence, Jr.,** pres.; **Roy Healy,** v.-p.; **G. Edward Pendray,** sec'y.; **Louis Bruchiss,** editor of society's journal.

Byron C. Foy has been named chairman of board of Jack & Heintz.

ATA International Committee Members: **C. R. Smith,** AOA; **T. E. Braniff,** BNF; **E. S. Ridley,** COL; **E. V. Rickenbacker,** EAL; **R. H. Herrnstein,** NEA; **Croil Hunter,** NWA; **J. H. Smith, Jr.** PAA; **G. Vidal,** Panagra; **C. Bedell Monro,** PCA; and **Jack Frye,** TWA.

E. J. Burkhardt has been named chairman of Aviation Advisory Committee of American Petroleum Institute.

Harry D. Miller and **Frederick D. Gearhart, Jr.,** have been named directors of board for Atlantic Central Airlines.

Richard D. Peterson has been named East Coast sales engineer for Ryan, with hq. in Washington, D. C.

S. H. Grinnell has joined Pacific Airmotive Corp. as supervisor of building-expansion program.

M. P. Bickley has been appointed cargo sales mgr. for UAL.

Ernest R. Breech, formerly Bendix Aviation Corp. pres., has been named exec. v.-p. of Ford Motor Co.

Dr. William R. Sears, chief of aerodynamics for Northrop, has been named first director of Cornell's Graduate School of Aero Engineering.

John R. Bloss has been re-elected pres. of Cleveland Aviation Club.

E. L. "Jack" Roseberry has joined Globe Aircraft.

Errata: Through a misprint, **Richard W. Millar** was mentioned in April Calling Names as "chairman" of Northrop's board. Correctly, item should have read "vice-chairman". . . . **H. G. Leslie,** recently elected chairman of engineering and maintenance for ATA, has not given up his position as supt. of maintenance for EAL, as was mistakenly stated in May Aviation People.

CAA announcements: **T. P. Wright,** administrator, has been awarded Medal of Freedom by War Dept.; **Walker Percy** has been named coordinator of PICAO.

Eric Olsen has been named mgr. of Aviation Div. of Wayne Pump Co.

George Tristani, Jr., has been named exec. dir. of Trans Caribbean World Airways' Puerto Rico office.

Steve Canton has been named Air Express Div.'s publicity representative.

B. A. Evans has been named mgr. of wheel and brake manufacturing dept. of B. F. Goodrich.

Winston H. Thornburg has joined Wendell P. Colton Co., advertising agency.

American Assn. of Airport Executives Officers: **Woodruff De Silva,** pres.; **Neil Brackstone,** v.-p.; **Hervey Law,** 2nd v.-p.; **Douglas Langstaff,** 3rd v.-p.; and **Pat Moore,** treas. & sec'y.

Jay R. Haymond has been appointed supt. of perishable traffic for air cargo div. of UAL.

George L. Hayes has been appointed gen. sales mgr. of ACT.

AA appointments: **Col. George C. Van Nostrand** has been appointed asst. to vice-president **T. C. Drinkwater** in Wash.; **Floyd M. Williams** has been appointed dir. of airmail service on Wash. staff; and **J. T. Farrah,** mgr. of industrial engineering branch of engineering dept., has been named aircraft procurement representative at Boeing Aircraft, Seattle.

★ OBITUARY ★

Jacob C. H. Ellehammer, Danish aviation pioneer and first to fly a heavier-than-air, man-carrying machine in Denmark and Germany. Experimenting with an engine-driven plane simultaneously with Wright Brothers, he made several short flights in 1906. He is also credited with starting experimentations with helicopters in 1912.

THE WASHINGTON WINDSOCK

By BLAINE STUBBLEFIELD

Supreme Court decision awarding damages to that man whose chickens died because of low flying over his farm doesn't change air law. U. S. holds sovereignty of air from "immediate reaches" above ground. Property owner can't get injunction against low flying—but he can collect if he can prove damage.

CAA's "flight plan assistance service" is resulting in fruitless searches for pilots who are not lost but merely didn't register out. The idea sounded all right, but it made another paper job for flyers who had enough already.

British claim their Rolls Royce Nene jet engine is world's most powerful. It develops a full 5,000-lb. thrust. American engineers fear English will arrive here one day with first jet or turbine transport plane.

Sea-Air Committee, fronting in Washington for shipline air services, is hopping mad because CAB and the President ruled out all maritime-air applications in the big Latin American award of routes. FDR had thumbed down certificates for shiplines in a decisive letter, and Truman carried out his policy, with definite approval of the State Department. But the Committee will go on arguing, forcefully, that foreign shipping gets air certificates and that U. S. lines should, too.

CAB was on a spot while non-sched air services sprang up in swarms. Any Government opposition would have brought cries of interference. Now, scores of the companies will go broke.

Getting into Moscow with U. S. airlines may take 5 to 15 yr., depending on how long Russia persists in her "off limits" philosophies. It is figured that millions of Soviet citizens want to lift the iron curtain and set up communications with the world.

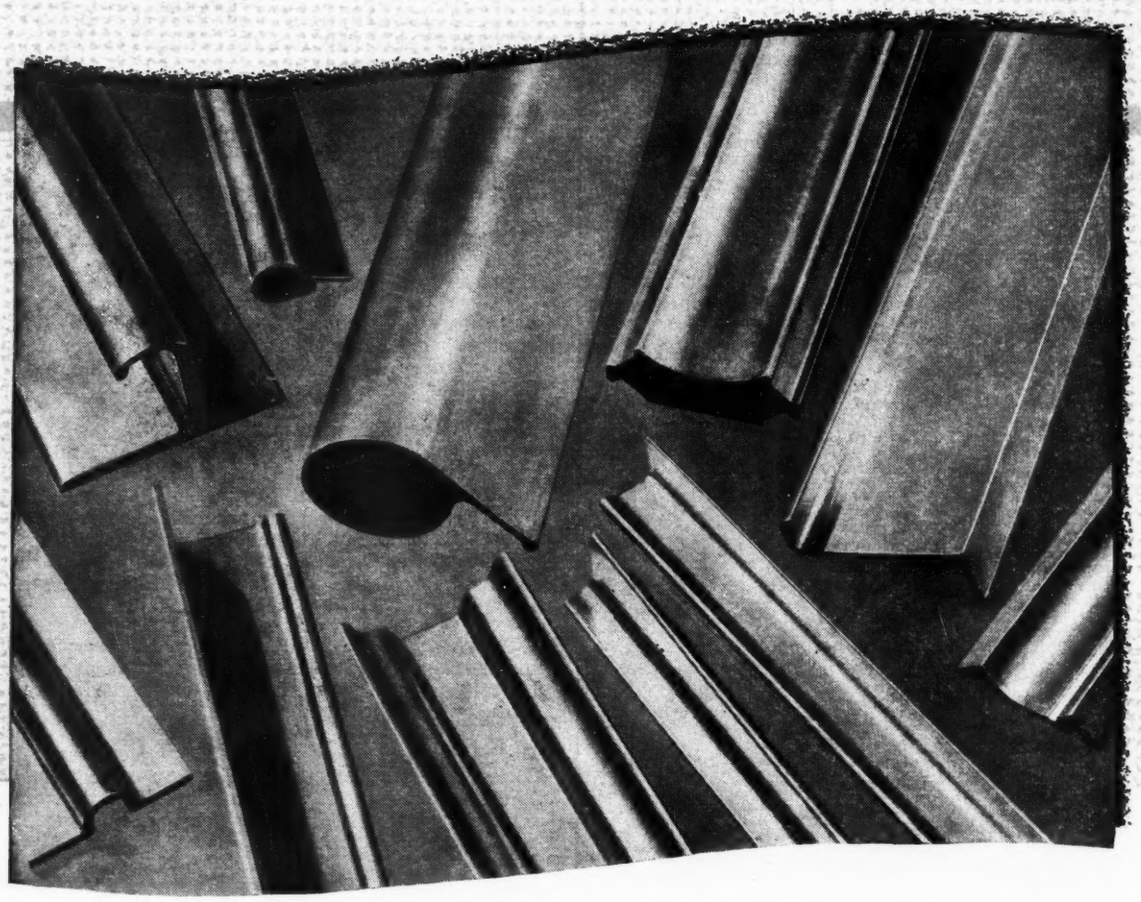
Argument by CAB that local business, not the trunkline operator is best suited to promote feederlines, is now accepted policy for practical purposes. Three times this year the trunklines failed to break in on feeder applications.

NEW ANGLES FOR NEW PROBLEMS

Bell P-63 fitted with new wings is being used as flying lab by Bu Aer to test design configurations essential to break through transonic range into faster-than-sound flight. Designated L-39, craft's wings are swept back 35 deg. and have nearly full-length slots. (Press Assn. photo)

Dies cost so little . . .

it pays to design your own Magnesium Extruded Shapes



Alcoa's charges for extrusion dies are small; $60 to $150 would pay for the die for any shape shown here (under 3 inches circle size). So, where a standard shape won't do exactly what you require, it'll probably pay to design a special shape that will. You'll quickly absorb that die cost.

Shapes that interlock, or provide extensions for attachment of other parts, save on assembly time. The intricate shapes possible with the extrusion process avoid having to build up complicated assemblies.

Of course, with American Magnesium extruded shapes, you achieve the ultimate in weight saving—most efficient use of the metal, coupled with the featherweight lightness of magnesium. For help in using magnesium extruded shapes to best advantage, call the nearby Alcoa office. Or write:

Aluminum Company of America, Sales Agent for American Magnesium products, 1713 Gulf Building, Pittsburgh 19, Pa.

MAGNESIUM MAZLO PRODUCTS

AMERICAN MAGNESIUM CORPORATION

SUBSIDIARY OF ALUMINUM COMPANY OF AMERICA

Air Force, BuAer Budgets Greatly Shrunk; Allison Claims Lead in AAF Engine Output

. . . War efficiencies vanish in switch to peace . . . 1,682 craft made in April; 148 are military ships . . . Rocket testing of airfoils is Cal. Tech. highlight . . . Report on turbine alloys.

Marked curtailment of military aviation is seen in the new 1947 budget estimates for AAF and BuAer. AAF figure is $1.2 billion, as compared with $11.3 billion for '46.

Estimate contains: For aircraft, $401,890,000; operation of depots, $341,584,145; research and development, $174,257,000, which is nearly as large as for '46, and is larger than for '45; and for ATC, $10,000,000. Provision is made for resumption of glider activities.

House Appropriations Committee trimmed BuAer's fiscal '47 budget to $805,760,000, which includes $310,000,000 for new aircraft, and $100,000,000 for research and development. Navy estimates its peacetime strength under Congressional curtailment at 25% of wartime personnel; 80 continental air stations as compared with 177 in wartime; and 25 of 100 carriers. Funds will permit purchase of 1,359 airplanes in fiscal '47, including 854 fighters, and 390 dive bombers. Engine research will emphasize gas turbines; but work on reciprocating types will continue.

Allison Claims It Leads In AAF Engine Output

That it has taken the lead as the AAF's largest power plant producer, is the declaration of the Allison company. Its '46-'47 production program is scheduled to comprise use of all its wartime-operated plants, including the 2,000,000-sq.ft. RFC Maywood site, and peak output is expected to utilize 6,000 employees against present 4,000.

Deliveries of Allison-built J-33 (GE I-40) jet engines, which power the Lockheed P-80As, plus much-improved V-1710 liquid-cooled reciprocating engines, which power the North American P-82 Twin Mustangs, are expected to total 9,000,000 hp. by the end of '47, states Gen. Mgr. E. B. Newill.

War Efficiencies Vanish In Switch to Peace

Lack of quantity production, evident since large-scale cancellations hit the industry at the end of World War II, is now heavily felt, with unit costs reaching a peak despite drastic economy measures in production departments all over the country.

The war period high of 96 airframe-pounds per employee and cost of less than $5 per airframe-pounds have been sharply reversed, with present output estimated at 10 lb. per employee, and airframe costs at $25-30 per pound.

In addition to a lack of unlimited quantity production, the industry is also faced with: A let-down in individual effort (since needs do not appear as urgent as they did while we were fighting), disappearance of the high degree of tooling formerly used, and sharp curtailment of highly productive processes.

Much less elaborate tooling is now evident, with greater accent upon the individual's skill to perform several diverse operations. Again, not as much use is made of molds, dies, and patterns, because these methods are far too expensive for limited output, although they pay for themselves when used on a large scale. Increasing complexities in aircraft design, aerodynamics, power plants, control equipment, have also helped boost costs. Rising labor and material costs also shortening of flow-production patterns, are further reasons

Some headway is being made in an attempt to find a solution to these difficulties. Simplification of design is foremost, so that fabrication times and costs may be alleviated without sacrifice of safety and in order that greater utilization can be made of employees' skills. Closing down of many specialized departments is also being carried out.

1,682 Craft Made in April; 148 Are Military Ships

Aircraft production in April totaled 1,682, including 1,534 civil planes and 148 military, with latter counting in 50 radio-controlled target craft and experimental types, according to AIA and Commerce Dept.

The survey showed unfilled orders for 27,670 civil planes, valued at $346,575,011. Some of these orders will not prove to be "solid" when delivery time comes, but others will have been taken.

April military production is at the rate of only 1,775 planes a year, and a further slump is expected this summer.

Rocket Testing of Airfoils Is Caltech Highlight

An indication that rockets may, within limits, supplement the work of costly wind tunnels, can be found in the pages of a lengthy report by Caltech describing work done by that institution on military rocket research. (also see picture on this page). That the ranges are readily foreseen is brought out in the announcement that Caltech recently received building priority for construction of a $150,000 research lab to have flow speeds of over 3,000 mph.

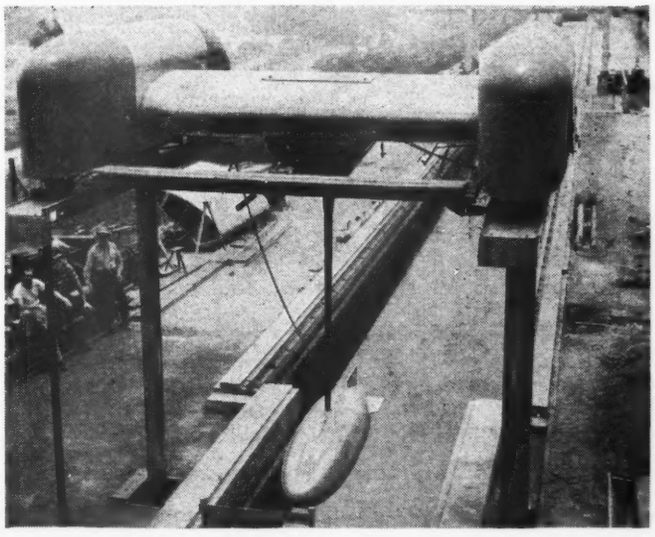
Now under development, and showing signs of being very successful, is the RAFT (Rocket Air Foil Tester) which carries a small scale airfoil at the nose of the test rocket and, by means of telemetering devices, transmits performance characteristics of the airfoil to a ground station. Cost of testing by this method is described as very low.

Another interesting development is work being done with ceramic liners for rocket motors, to enable operation at higher temperatures (up to 6,000 deg. F), and at relatively higher efficiencies. This ceramic research is being extended in application to the structures of turbine blades.

Report on Turbine Alloys

Four new reports issued by the Office of Publications Board, Dept. of Commerce, give chemical and physical properties of alloys potentially useful in gas turbines operating at 1,350 to 1,500 deg. F.

The reports are by U. S. Naval Experiment Station, MIT, Westinghouse, and other laboratories. OPB quotes prices for the reports, in the form of microfilm or photostats.



SWOOSH BOMBS GOING UNDERWATER

First picture of hydrobomb towing basin built by Caltech, Pasadena, Cal., as part of overall jet and rocket propulsion program secretly conducted for military services. Two prototypes were built for AAF, one by Westinghouse, other by United Shoe Machinery Co. Designed for aerial launching at speeds up to 350 mph., hydrobomb travels underwater at 70 mph. driven by solid-propellant rocket unit delivering 2,200-lb. thrust for 30 sec. Range is 1,000 yd., gross wt. approximately 3,200 lb., with 1,250-lb. warhead.

★ INDUSTRY MEMOS ★

Hockaday Aircraft is conducting factory site study at Oakland, Cal. Company has 1,200-plane backlog of orders for 180-mph. two-place Comet.

Schweizer Aircraft obtained permission to use Chemung County (N. Y.) Airport for glider school and field testing of sailplanes.

Ryan will make exhaust rings and accessories totaling $200,000 value for Convair 240s contracted for by AA and WAL.

Republic, with $84,000,000 backlog, may soon receive new contracts totaling $45,000,000 for P-84 jet fighters, reconnaissance craft, and Rainbows.

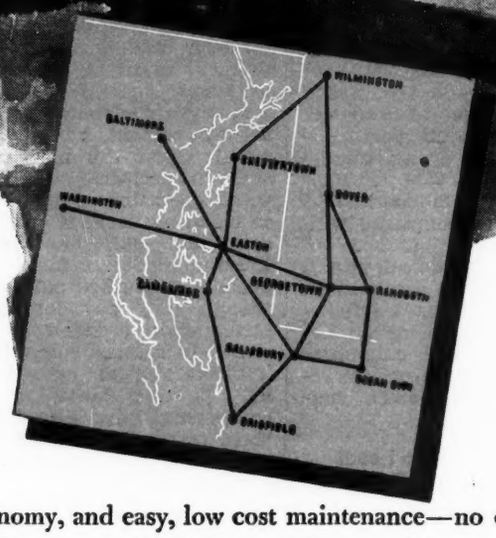
Douglas plans delivery of DC-6s and DC-3C Executives this month, and volume runs of Navy AD-1s are under way at El Segundo. In first third of '46, company delivered almost $20 million of new and converted craft.

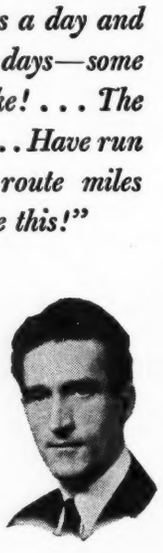
Boeing sales-engineering teams will conduct world-wide marketing coverage for its new Model 417 transport.

Bendix Aviation expects to own or lease over 4,275,000 sq. ft. by end of fiscal year, compared to about 2,180,000 as of '39 end. For fiscal year ending Sept. 30,

"War was never like this"... says NC 730

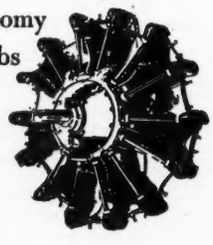
"I had it soft in the Army... Declared surplus, bought by Maryland Airlines, first of my type to be modified for commercial flight, given a new paint job... I went to work on July 20, 1945, on the Washington, D. C.—Rehoboth, Del., stretch... Made 7 round trips a day and 14,400 route miles in the first ten days—some with weather a duck wouldn't like!... The 100-hour checks came every 7 days!... Have run more than 3,000 hours, 416,000 route miles since August... War was never like this!"





"NC 730 with Jacobs R-755-9 engines inaugurated our service," says James E. Ryan, Vice-President of Maryland Airlines, soon to connect Washington, D.C., Baltimore and ten other Maryland and Delaware cities. "Together with three other Cessna UC-78's put in service later, these Jacobs-powered transports travelled more than a million miles in less than a year—with only routine engine care, service and overhaul!... For absolute dependability, top performance, operating economy, and easy, low cost maintenance—no one can find an engine better suited to small transport requirements than the Jacobs."

Such a record requires no elaboration... And now available is the improved version of the R-755-9 ... the Jacobs R-755A which delivers 33% more power with no increase in weight, consumes even less fuel and oil per hp hour! Other new Jacobs engines... with many valuable innovations, designed to meet current and future installation requirements, built with basic stamina that assures continued peak performance, dependability and economy ... are well worth waiting for!... Jacobs Aircraft Engine Company, Division of Republic Industries, Inc.



JACOBS • Pottstown, Pa.

Division of Republic Industries, Inc.

'45, expenditure for research and engineering was $18,300,000. Company has been selected to work with Navy BuOrd and John Hopkins Applied Physics Lab on supersonic guided missile program.

Martin sold 40 of 303s to NWA, which expects first of new craft by summer of '47.

Lockheed sold TWA 13 more Constellations, bringing airline's purchase of this craft to 49.

General Electric is supplying TWA with power generating equipment for 45 DC-3s in airline's modernization program.

Globe's 125-hp. Swift, priced at $4,395 for standard model, has been certified by CAA. Production schedule for this month is set at eight daily, with ten per day for Aug.

Johnson Aircraft's production on Rocket is being stepped up to ten daily following enlargement of facilities at Ft. Worth plant.

Piper's current list-price backlog is over $25,000,000. Company's 20,000th Cub, recently completed, was 3,489th since V-J Day.

Minneapolis - Honeywell's research and development on 31 aviation engineering projects is headed by work on company's automatic flight control systems.

Airadio's Super 52, two-way communication system, has been approved for All American Aircraft's Ensign. Later model craft will provide installation as standard equipment.

Aero Engineering's twin-engine Aero Commander prototype, now under construction at Culver City (Cal.) Airport, will probably be test flown this fall. Originally planned as 4-5-passenger $12,500 craft, it is now planned as seven-seater powered by 200-hp. Lycomings, at increased price not to exceed $17,500.

★ FOR THE RECORD ★

His own consulting firm has been established by Charles A. Rheinstrom, who recently resigned as AA v-p, sales, and director. Organization will give advisory service on airline sales, traffic, advertising, engineering, operations, public relations, etc. Offices are at 521 Fifth Ave., New York 17, N. Y.

Skyways Transport Service of Detroit has started fly-away service on nation-wide basis, Operations Manager Seymour Karp reports. Rates average 12½¢ per mi. on most personal planes, and include complete insurance, bonded pilot, and fuel.

Santa Fe Railway has organized Santa Fe Skyway, with offices in Wichita, Kan. Initial service with converted C-47s will be for cargo in railway's territory, but passenger charter service may later be added.

Taylor Turbine Co., headed by P. B. Taylor, former v-p and general manager of Wright Aeronautical Corp., will make Rolls-Royce turbojets in this country under license. Pending establishment of plant facilities, company's address is c/o Mr. Taylor, 80 Norwood Ave., Upper Montclair, N. J.

Ryan Aeronautical Co. has opened eastern headquarters for its Metal Products Div. at 516 Bond Bldg., Washington, D. C., with Richard D. Peterson as eastern sales engineer and James Stainaker as engineering representative.

Bendix West Coast expansion moves executive, sales, and engineering personnel to new building at 7551 Melrose Ave., Hollywood, and service department to 6454 Lankershim Blvd., North Hollywood, latter with E. O. Cooper in charge.

Carl L. Norden, Inc., will center peacetime development and production activities in recently-purchased building at 121 Westmoreland Ave., White Plains, N. Y. Building is undergoing extensive alterations.

Oakland Airport's historic quarters of the Boeing School of Aeronautics will re-open this Fall, with occupancy by Ralph Hemphill's Aero Industries Technical Institute, which is moving from Glendale, where it was founded before war.

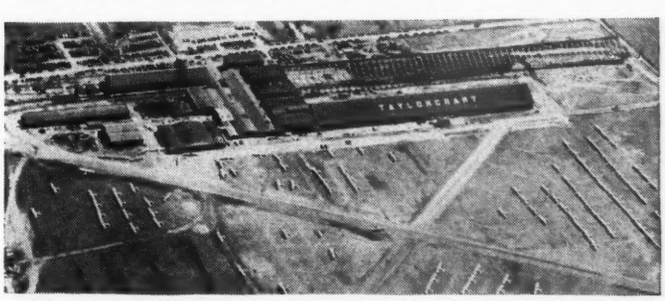
Air Affairs, Inc., "the world's first international project to study and predict the social effects of aviation", has been formed by a group of over 100 individuals and 40 companies throughout world. A quarterly publication, "International Journal of Air Affairs", is "focal point project." Offices have been opened at 1829 G. St., N.W., Washington, D. C.

Firm which will include airport design, inspection, and report service has been opened by M. T. Decker, formerly partner in Downer, Greene & Carrillo, and for past four years chief of design at Idlewild Airport. Address is 15 S. William St., New York 4, N. Y.

Revere Co. has changed its name to Revere Corp. of America.

Frederic Flader, Inc., has moved offices and factory from 775 Main St., Buffalo, to Erie Ave. & Division St., North Tonawanda, N. Y.

United Helicopters is moving to new quarters at 625 El Camino Real Palo Alto, Cal., for production of two-place Commuter designed by Stanley Hiller, Jr., president.



FOR STEPPING UP T'CRAFT OUTPUT

This aerial view shows a new assembly wing now under construction at Taylorcraft, Alliance, Ohio. When completed (late Summer), wing will greatly increase company's production, currently given as 30 planes daily. Structure will add 200,000 sq. ft. to present facilities. Over 100 Taylorcraft's are spotted around field awaiting delivery.

Where the clock is stopped for *Precision* heat-treating

You can measure surface hardness in a precision part—but you can't measure strain relief without destroying the part itself. That's well understood, but this fact often is overlooked: You can control temperatures and be sure of specification hardness—but you can't assure strain relief and ductility with controlled temperatures *alone*. It takes temperature *and time* to attain ductility. That's why craftsmen at Indiana Gear Works "stop the clock" in the final stages of heat-treating . . . that's why every hard-to-make gear or other precision part is tempered *hours after* blue-print hardness is reached.

The care taken in this—and every other vital precision process—is one reason why today so many leading manufacturers turn their precision gear problems over to IGW—past masters in precision for 44 years.

Indiana GEARS

GEARS • CAMS • INTRICATE AND PRECISE MACHINE PARTS

INDIANA GEAR WORKS • INDIANAPOLIS 7, IND.

CAB Okays Network to Serve Latin America; Maintains Policy Against Sea-Air Proponents

. . . North Atlantic fare cuts determined by IATA . . . PICAO makes tech strides; picks Montreal as hq . . . Await pilot-pay decision . . . Local feeders still favored.

Further promoting communications and commerce between this country and Latin America, the U. S. authorized a vast new network of American flag airlines to many points south of the border. Remembering lessons learned of deficient U. S. aviation in this hemisphere during the recent war, CAB certificated international extensions of nine airlines, and the President, at the instigation of the State Dept., added still others under his authority as final arbiter on U. S. foreign air services.

At the same time, the Government sustained its long-standing policy against air operations by sea shipping companies, refusing several maritime applicants, to their bitter disappointment. The Sea-Air Committee has announced that it would continue its efforts through Congress and public opinion.

Major extension in the Latin American case was Braniff, down the West Coast to Buenos Aires and Rio de Janeiro. This decision was handed down by the President, beyond the will of the Board.

Many competent persons, as well as two CAB members, felt that traffic in the Latin countries will not support a third trunkline and the other new services in competition with 20 or more foreign lines. At least 13 Latin lines are seeking entrance to the U. S. But opinion of the other two members, and of the State Dept. is that benefit to the general welfare of the hemisphere will more than offset any required subsidies.

AA was certificated from El Paso to Mexico City; C&S from Houston and New Orleans to San Juan, Puerto Rico, and to Caracas, Venezuela; Colonial from Washington and N. Y. to Bermuda; National from Tampa and Miami to Havana; PAA, Houston and New Orleans to Guatemala City, via Merida, and N. Y. to San Juan, with numerous lesser extensions, including one from Brownsville, Tex., to Houston, without local service; Panagra, numerous extensions to its existing West Coast South America system, without the long-sought entry into the U. S.; WAL Los Angeles to Mexico City; and EAL New Orleans to Mexico City, and Miami to San Juan.

North Atlantic Fare Cuts Determined by IATA

Reductions of about 12½% in trans-Atlantic passenger fares were proposed by representatives of ten international air carriers at IATA's recent North Atlantic Traffic Conference. Finally the highly important and hitherto elusive factor of operations costs was pinned down.

The new fares were to go into effect at press time (June 25), provided the appropriate governmental authorities approved them on, or prior to, that date; otherwise they must await the last of such approvals. Represented at the conference as qualified voting members were: John E. Slater, AOA; V. G. Crudge, BOAC; V. H. Dubourcq, KLM; V. E. Chenea, PAA; T. Nilert, SILA; G. R. McGregor, TCA; and E. O. Cocke, TWA. Non-voting members (being prospective international carriers), were: H. Lesieur, Air France; P. Beck Nielson, Danish Airlines; and Gert Meidell, Norwegian Airlines.

Proposals were determined on services scheduled for this year's end, when it's expected that about 100 weekly flights, making available about 500 seats daily, will be in operation by IATA members. General opinion was that passenger load factor would run about 65%. According to AOA's John E. Slater, "Rates were based on low estimated operating costs, rather than on high or even an average of the proposals submitted".

PICAO Makes Tech Strides; Picks Montreal as Hq.

Assembly of the Provisional International Civil Aviation Organization met at Montreal, May-June to consider voluminous agenda previously worked out by PICAO's committees. The temporary Organization is to be replaced by the Permanent Convention on International Aviation, and Montreal has been selected as headquarters.

The U. S. delegation head, W. A. M. Burden, told the Assembly at Montreal that it should go easy on multilateral agreements, pending crystalization of world opinion. He asked that the 21st seat on the Interim Council, reserved for, but unoccupied by, the Russians be filled and Eire got this seat.

Most progress was achieved in the technical field, with final meeting of the Assembly making the Organization the trustee for arranging financing of necessary avigational equipment where the nations requiring these facilities are unable to carry the costs, also in non-sovereignty area like the high seas.

The Assembly ended, however, with the controversial "fifth freedom" question still no nearer solution.

Await Pilot-Pay Decision

Air Line Pilots Assn.'s threatened strike against TWA and its demands for higher four-engine pay, were under study last month by a three-man emergency fact-finding committee, appointed by the President, as required by the Railway Labor Act, which governs airline disputes.

ALPA was determined to deal with one airline at a time, while operators insisted that their wage negotiating committee act for all. Outcome on that is unpredictable; ALPA is expected to win a small part of its pay demands.

Fact finders' decision on the evidence was awaited as we went to press.

Local Feeders Still Favored

CAB, re-affirming its position that local operators are better fitted than are trunkline operators to promote business on feederlines, has granted certificates to Empire Air Lines of Lewiston, Idaho; Southwest Airways Company, of Beverly Hills, Cal., and West Coast Airlines, of Seattle.

Trunklines, which had applied for the services, failed for the third time this year to break into feeder operations. The Board approved the plans of the Southwest and West Coast companies to operate combination mail pickup and passenger services, for economy.

SPEEDY VOUGHT "SKIMMER" MAY BE NEW 'COPTER RIVAL

This weird-looking XF5U-1 Navy fighter is stated to have finally licked speed range bogey that has always plagued plane builders. Powered by conventional engines, it's said to have a top speed of 425 and low speed of 40 mph. With water injection, ratio is 460:20; and with gas turbines, 550:0. Amazing performance is credited to specially articulated type props, developed by Hamilton Standard, which can be adjusted to operate in fashion similar to 'copter rotors. XF5U-1 depicted has two 1,350-hp. P&W buried radials with right-angle transmissions to props. In emergency, special clutches permit either engine to turn both airscrews. Plane is nicknamed "Skimmer".

★ CROSS COUNTRY ★

CAA notes that there are at least 2,730 N-S air carriers, using 5,529 planes, now in operation. In addition, CAA reveals that there are over 4,630 companies known to be conducting miscellaneous commercial flying operations.

New Airlines: Superior Air Lines, using DC-3s, started all-Ohio passenger and freight service based at Youngstown. . . . Willis Air Services, based in N.Y.C., started N.Y.-San Juan, Puerto Rico, service. . . . Northern Airways, is new carrier serving major North Dakota cities, with flights originating at Grand Forks. . . . Texas-New Mexico Airlines, Amarillo, plans to inaugurate six CAB-authorized feeder routes in that area using DC-3s and Lockheed 10s.

UAL: Airline broke all its own previous traffic records during recent rail strike when, in two days, company flew some 14,000 passengers and about 327 tons of cargo. . . . Airline plans to spend $750,000 on construction of a passenger terminal and improvements at Hubbard Field, near Reno, Nev. . . . Company is modifying DC-3 Cargoliners by installation of new 53-in. wide cabin doors, making it possible to load crates as large as 53x57x60 in. Fuselage structure was redesigned to equalize stresses, with weight increased by about 48 lb.

ATC opened first scheduled air service over North Pacific Great Circle route, said to cut 12 hr. from present mid-Pacific route. One round trip every other day is contemplated, and only freight and mail will be flown until crews are more familiarized with route.

EAL dedicated new hangar in Boston capable of holding three Douglas DC-4s or seven DC-3s. Structure covers 40,000 sq. ft.

★ INTERNATIONAL BRIEFS ★

ENGLAND — Announcements in Parliament stated that both Hermes and Tudor II have passed all prelim tests and are now in full production. First commercial models are expected to be in service by winter.

Details have been published on British-Eire air pact, disclosing agreement for operations by BOAC, Aer Rianta Tta, and Aer Lingus Tta. BOAC will only operate international services to North America via Ireland. However, Aer Rianta, BOAC subsidary, will also operate to North America by 1947 with recently-ordered Constellations. Aer Lingus will fly to points in British Isles, Europe, and Scandinavia.

Unable to get satisfactory accommodations at Idlewild, BOAC turned to town of Islip, Long Island, leasing space at the Army-built airport there. Trans-Atlantic service opened first of this month with Constellations making twice-weekly round trips at $375 one-way and $675 for round trip. Heathrow is London terminal, with intermediate stops at Rineanna, Eire, and Gander, Newfoundland.

Skyways, Ltd., has been formed as charter operator, headed by Brig. Gen. A. C. Critchley, former BOAC Director-General, as chairman. First plane, an Avro York, is under charter to Anglo-Iranian Oil Co., transporting personnel and cargo. BOAC will act as sole agent for Skyways, which will also use Lancastrians and DH Doves.

Ministry of Civil Aviation has reported that Vickers Vikings will be in service on continental routes this summer.

BSAA and Flight Refueling plan operational tests of refueling in midair on Great Britain-South American routes this summer.

There appear to have been no takers on proposed London-Vancouver air race. Event was slated for July 1-4 in connection with Vancouver diamond jubilee.

RUMANIA — Russia and Rumania have formed a new airline, which will take over all assets of LARES, prewar Rumanian line. Arrangement is said to be similar to that recently made by Russia and Hungary. Operations will be conducted with Russian-built DC-3s.

FRANCE—Three Latescore 631 six-engined flying boats have been sold to Argentine Government, probably intended for latter's airline operation to France.

SWEDEN—SILA recently completed a survey flight to South America with converted Boeing B-17, preliminary to opening regular service in Fall with DC-4s.

DENMARK — Danish Government is completing plans for reorganization of its air force, which is to be equipped by British manufacturers.

NORWAY—Start of operations of DNL, new Norwegian line, was marred by crash of a Junkers near Oslo, killing 13. Col. Bernt Balchen is DNL general manager.

CZECHOSLOVAKIA—CLS has started operations to Warsaw in collaboration with Polish LOT. Route is to be extended to Moscow in near future.

HUNGARY — Russo-Hungary civil aviation agreement is under scrutiny by U. S. authorities, who fear it will contain clauses excluding all other countries. Meanwhile, American military authorities have requested landing rights at Budapest.

ITALY — Approval of Italian-TWA contract, with only its exclusive feature eliminated, is expected to make for an early start of operations.

INDIA — Indian National Airways inaugurated three trunk routes: Delhi-Calcutta, Delhi-Karachi and Delhi-Peshawar (Khyber region). Soon to be inaugurated are Delhi-Madras route, and extensions to Rangoon, Bangkok, and Cairo.

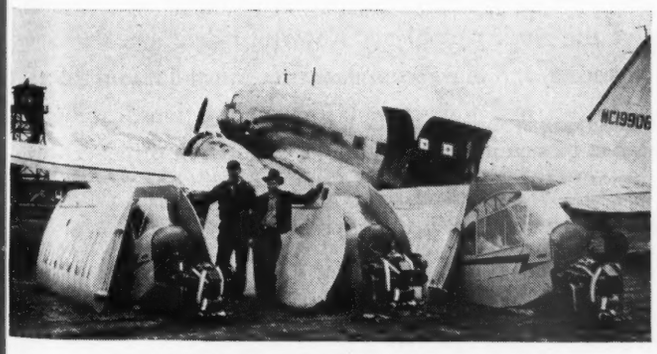
A 20-yr. plan for establishment of a self-sufficient national aircraft industry has been approved by Indian government. First stage calls for expansion of repair and maintenance base at Bangalore at a cost of $390,000. First planes to be produced will be trainers required by Royal Indian Air Force.

WORLDATA . . . . . By "VISTA"

Britain is pressing plans to convert its entire aviation program to use of jet power plants. There have been frequent indications before that many new commercial aircraft would be tested with jet units, but John Wilmot, Labor Minister of Supply, indicates that reciprocating engines will soon take a back seat. Among planes now under construction with jet power are the 100-ton Saunders-Roe six-engined boat, three of which have been officially ordered, and the Brabazon (Bristol 167), four of which are being built. Other planes being studied for jet-power are the Hermes, Tudor II, and a new Miles transport. RAF is also concentrating on new jet aircraft, including the DH Swallow, Messerschmitt-inspired flying-wing interceptor with swept-back wings. Among new jet engines being tested are the DH Ghost, with 5,000-lb. thrust, and Rolls-Royce Nene, with which an attempt at breaking the 606-mph. world speed record is in the offing.

France is sparing no efforts to regain her former position in world aviation. With numerous transports on order, some from the U. S., plans call for services to N. Y., Canada, Latin America, and Tricolor possessions. Trans-Atlantic service with Douglas DC-4s is expected to start shortly, and when Lockheed Constellations are delivered later in '46, the DC-4s will be switched to service to Buenos Aires and Indo-China. Further highlighting France's efforts will be the annual International Aeronautical Exposition in Paris this November, to be held in the famous Grand Palais after a war lapse of 8 yr. Because Air France at present has only a relatively small fleet of transports, the company is currently concentrating on connections with the possessions, most of which are receiving twice-weekly service.

Mexico is eyeing award of numerous routes to Mexico City with some apprehension, not only because of inadequacy of the present Federal airport at Mexico City, but because of fear that Mexican companies will be swamped by foreign competition. The recent CAB Latin American case decision put three additional American lines into Mexico City—Western, Eastern, and Braniff. In addition, there are French, Canadian, Cuban, and Venezuelan plans for routes to the Capital. While the country undoubtedly will attract much traffic because of its commercial importance and tourist attractions, there are well founded doubts whether the total traffic will support all the proposed services. Total international traffic to and from Mexico is now running at a rate of about 120,000 passengers yearly, or some 330 per day. Using DC-4s, four round-trip schedules daily could handle this volume. Growth of traffic is not expected to be rapid enough to require the 20 to 25 round trips projected.



CUB CUSTOMERS, IT SEEMS, ARE IN A HURRY

Three Piper Cubs shown on arrival at Anchorage, Alaska, where they were flown from Seattle by Wallace Air Service of Spokane, Wash. Two such flights have already been made; four more are planned by Larson Alaskan Distributing Co., Alaskan distributors for Piper. Aerial delivery of lightplanes not only gives greater speed, but also eliminates cost of heavy crating necessary for surface transportation.

PHILIPPINES — Official sanction was given two airlines to start international services. Far Eastern Air Transport will operate to Shanghai, America, and Borneo. Pacific airline, subsidary of Philippine airlines (in turn a TWA subsidary), will operate to China and Java.

AUSTRALIA — Australian National Airways, selected as interim operator to U. S., will start with DC-4s, after test flights are completed.

Substantial reductions have been made in air fares to England, cuts running from $175 to $325, depending upon equipment. QANTAS will operate twice-weekly flying boat service to England with Hythe type aircraft, carrying 16 to 22 passengers.

Cost of 61 Lincoln heavy bombers built in Australia was disclosed to be $509,000 each, including spares, cost of plant, and full equipment.

ANA lost its case in Supreme Court for permission to appeal against Court's decision that Government may legally operate airlines. New government company will be known as Trans-Australian Air Lines.

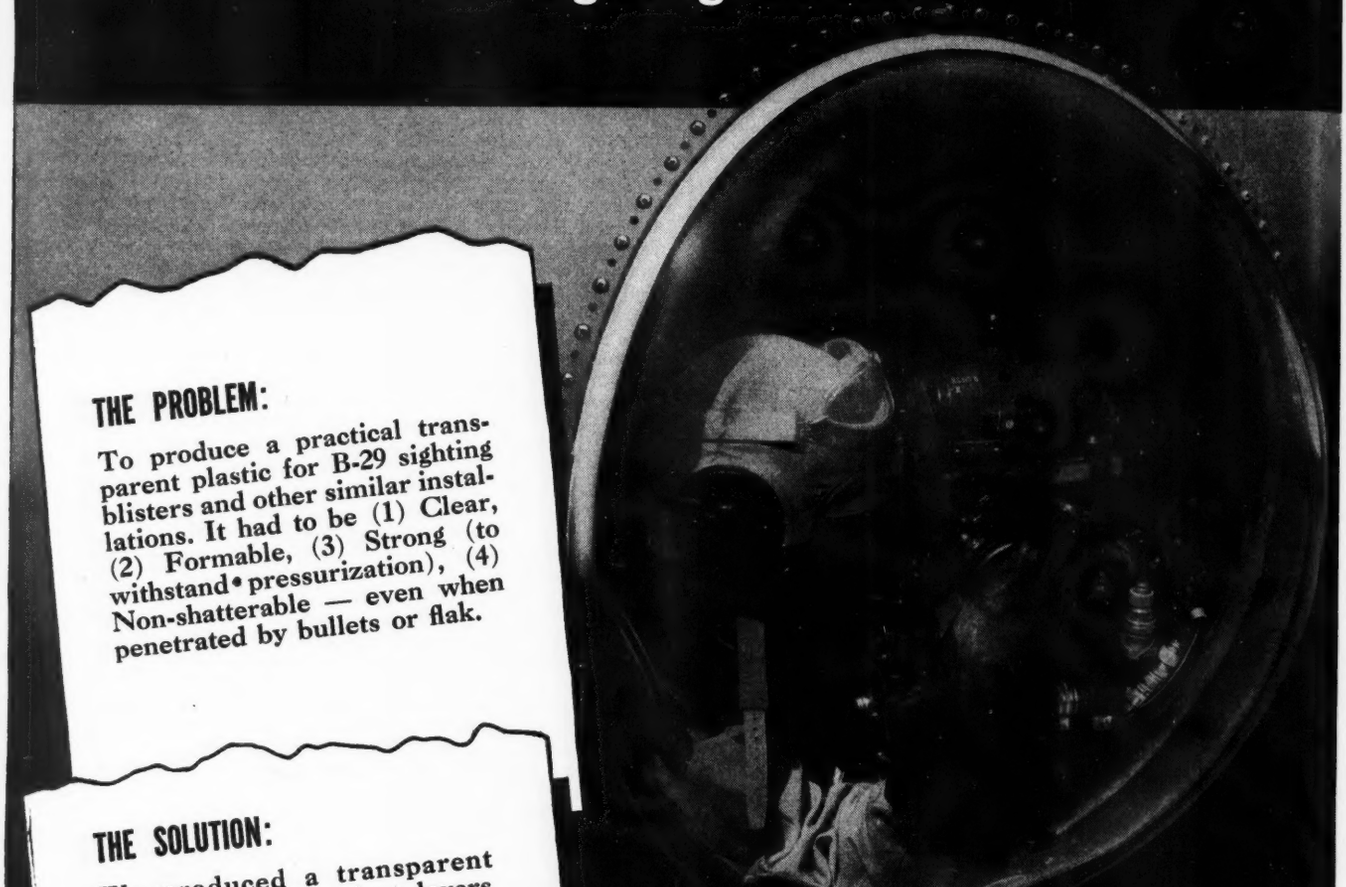
Because of extensive facilities for production of Rolls-Royce Merlins, it has been decided that all Australian aircraft, including DC-4s, will be powered by these units.

DH Vampires will be built in Australia—airframes at DH—plant on Bankstown Airport, Sydney, and Rolls-Royce turbojets by Commonwealth Aircraft at Melbourne.

CHILE—Negotiations with Australia are said to be in progress concerning establishment of a direct route between Chile and Sydney, eliminating present detour via U. S. Also under way with Brazil and Argentina are negotiations which may eventually lead to an "ABC" block,

"PITTSBURGH" DEVELOPMENTS IN AIRPLANE GLAZING

New transparent plastic meets all requirements for sighting blisters



THE PROBLEM:

To produce a practical transparent plastic for B-29 sighting blisters and other similar installations. It had to be (1) Clear, (2) Formable, (3) Strong (to withstand pressurization), (4) Non-shatterable — even when penetrated by bullets or flak.

THE SOLUTION:

We produced a transparent laminate consisting of two layers of methyl methacrylate with an inner layer of polyvinyl butyral plastic. The polyvinyl butyral inner layer functioned as a resilient diaphragm and retained the cabin air pressure even in cases where operational hazards caused rupture of both layers of methacrylate. This product passed all Army Air Forces tests and became a specified material for certain transparent areas in all B-29, B-32 and B-36 airplanes.

YEARS of experience in manufacturing safety glass, together with specialized production and research facilities, enabled "Pittsburgh" to play a leading part in helping to solve the glazing problems of wartime aviation. Perhaps our engineers, and our accumulated technical data on safety glass, plastics, and glass and plastic combinations, can be of assistance to you in the design and production of peacetime planes. Pittsburgh Plate Glass Company, 2266-6 Grant Building, Pittsburgh 19, Pennsylvania.

"PITTSBURGH" stands for Quality Glass and Paint

PITTSBURGH PLATE GLASS COMPANY

SPECIALISTS IN AIRPLANE GLASS • MAKERS OF DUPLATE AND FLEXSEAL SAFETY GLASS AND OF MULTIPLATE BULLET-RESISTING GLASS

which is seen excluding other countries' companies from operating local air service between Argentina, Brazil, and Chile.

CHINA — China National Airways (CNAC) recently ordered six surplus C-54s, which will be converted in company's own shops. Craft will be used on new routes to Tokyo, Manila, and Singapore.

BRAZIL — This country is now the leading air power in Latin America, having received more than 2,500 modern airplanes from U. S. under lend lease. However, Argentina is trying to surpass Brazil, buying aircraft in Britain, and allowing Miles, English firm, to start a plant in country.

ARGENTINA—It is reported that Dodero will shortly move its headquarters to Montevideo, after rebuff by Argentine authorities on proposed service to England and America. Dodero now owns four converted Sunderland flying boats, and several Douglas C-54s.

Service to England and Chile was inaugurated by FAMA June 4. Buenos Aires-Croydon route is via Natal, Bathurst, Lisbon, and Biscarosse, France. Chilean flights will connect B. A. with Santiago, using three DC-3s in conjunction with Chilean National Airways.

PERU—Plans to attract more international air commerce resulted in authorization for several new routes into Peruvian territory. Panair do Brasil will fly from Brazil to Iquitos, while a new company, Aerovias Peruvianas Internacionales, will fly from Lima to Panama, New Orleans, N. Y., and Montreal. Permission is also expected to be issued to TACA to enter Peru, thus completing this company's circuit of South America. A new Chilean airline will also be granted landing and transit rights for its proposed flying boat service to New Orleans.

MEXICO—At Mexico City, Servicios Aeronauticos de Mexico, S. A., has started major engine overhaul base, said to be first of its kind in Latin America for civilian work. Cost so far is 3,000,000 pesos (about $600,000).

URUGUAY—Negotiations for an Anglo-Uruguayan air agreement are nearing completion, and it is believed a 5-yr. treaty will soon be signed. Duration of pact has been crux of discussions, with Uruguay favoring a 10-yr. limit and Britain an unlimited period.

AFRICA — West African Airways is now being formed to operate passenger and cargo air services in Gambia, Sierra Leone, Nigeria, and Gold Coast. Bernard Gross, formerly with Imperial Airways, has been appointed manager. He will headquarter in Lagos. BOAC will act as technical adviser, but West African is said to be independent of government-owned companies.

RUSSIA—Moscow states service to London will be inaugurated shortly. Other projected routes include those to Paris, Rome, and Tirana, Albania.

Making a 25,000-mi. reconnaissance of ice conditions in Arctic waters, a Soviet plane piloted by M. Titlov has completed a 8-wk. survey in aid of navigation. Longest single flight from Dickson Island base covered 3,000 mi. out and back, penetrating to within 50 mi. of Greenland—a non-stop flight of 19½ hr. Another single hop was north from Dickson Island into the Central Polar Basin, covering some 2,300 mi. in 16 hr. Areas surveyed included Greenland, Barents, Kara, and Laptev seas, also high latitudes of Arctic Ocean.

Civil aircraft again sprayed locust-infested areas in Iran, nearly 25,000 acres having been covered by early May. Reports state Iranian Government requested planes, which were furnished by Soviet Ministry of Agriculture and Central Administration of Civil Air Fleet.

JAPAN — Allied headquarters has decreed that no plane may fly over Jap territory without prior approval, under rules similar to those promulgated by Russians for territory under their control. New regulations provide: That only aircraft attached to occupation forces may fly over Nippon without Headquarters clearance; that Tokyo is to be sole port of entry; that no planes may leave Japan until complete cargo manifest has Headquarters approval; and also that approvals for entry are valid for only five days.

AVIATION FINANCE

ADDING IT UP.....By RAYMOND HOADLEY

Airline Operations. After reporting thumping big losses in the first quarter, we may now look for somewhat better results in the three months ended June 30. Fourteen air lines showed a March operating loss of $1,075,000, against $2,898,000 in February. Of the big four, Eastern Air Lines was the only one to operate in the black in the first quarter. But despite continued high costs, larger revenues should permit better earning power for all lines in the months immediately ahead.

Unfilled Orders. Latest backlogs of unfilled orders reported by the aircraft manufacturers show North American Aviation with about $75,000,000 in Government orders, in addition to initial orders for the company's Navion four-place private plane, which is scheduled to go into quantity production before Fall. . . . Republic has an $84,000,000 backlog. . . . And Fairchild Engine & Airplane now has $72,500,000 in unfilled orders, according to our latest check.

Current Earnings. Douglas reports profits of $1.85 a share for the quarter ended Feb. 28. Sales in the first four months of 1946 were $19,500,000. . . . United Aircraft reported a $505,000 first-quarter loss.

Airline Financing. Pan American Airways may do some short term financing later this year to meet payments on equipment orders. Most of the Lockheed Constellations and Douglas DC-4s are being paid for out of current funds, but progress payments also must be made for Boeing Stratocruisers and Republic Rainbows over the next year. . . . Meanwhile, TWA has arranged for an additional $10,000,000 with a life insurance company, bringing to $40,000,000 its total loans to finance new transports.

Dividend Changes. United Aircraft directors have reduced the semi-annual dividend from $1 to 50c a common share. . . . Ryan Aeronautical has declared an initial quarterly dividend of 10c. a share, also a special 15c. dividend. . . . Eastern Air Lines, which recently split its stock four-for-one, has established a dividend policy of 50c. a common share per annum. Effect is to double the $1 dividend paid in '45 on the stock prior to the split-up.

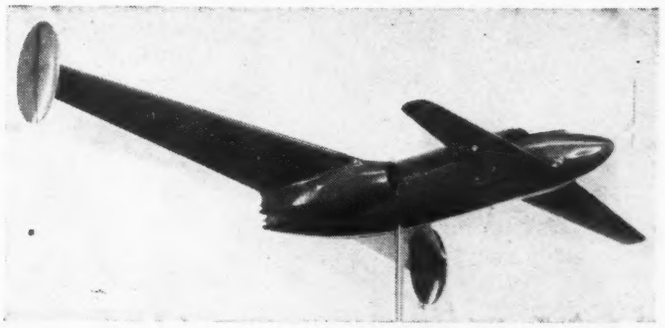
Airplane Exports. Between early '45 and early '46 airplane exports took a nose-dive from $180,000,000 to about $2,500,000. However surplus aircraft costing $87.700,000, including 1,379 two- and four-engine transports, have been sold abroad. This is over four times our domestic airline fleet in 1941.

Stock Splits. Latest aviation concern to join in the favorite corporate pastime of splitting its stock is Columbia Aircraft Products, which has split its common stock two-for-one. . . .Grumman has often been mentioned in Wall Street as ripe for a stock split, but company officials have never nodded to the rumors.

Redemptions and Loans. Fairchild Engine & Airplane Corp. has redeemed its 16,974 shares of preferred stock at $52.50 a share. . . . Aviation Corp. has paid off bank loans (of around $13,000,000) with the proceeds of the recent sale of American Airlines common stock, which brought in $18,000,000. The bank loans were incurred when the Crosley Corp. stock was acquired. . . . Lear, Inc., has made final payment of $500,000 on a $14,000,000 RFC loan.

Stock Financing. Johnson Aircraft is offering 2,000,000 shares of stock to the public to finance a $2,000,000 expansion program, which is to boost output to ten planes a day. The company has $5,000,000 in orders on which cash deposits have been made. . . . American Airlines is selling $40,000,000 in debentures and 400,000 of preferred stock to finance the company's $96,000,000 equipment program.

Personal Planes. Aeronca plans to produce 10,000 planes this year, against annual prewar output of 1,200. . . . Piper's production rate from mid-summer on is scheduled at 1,000 a month. Current backlog is $26,000,000.



PHILATELIST'S SPECIAL

Model of projected Miles M.63B jet-propelled canard-type plane submitted to British Postmaster General for high-speed mail delivery. Based on now-flying Libellula (see page 181, Sept. '44 Aviation), M.63B would have maximum cruising speed of 500 mph. for 2,000 mi., and economical cruising speed of 385 mph. at 36,000 ft., with 4,000-lb. payload. Unit would be powered by two Rolls-Royce Derwent Vs or three Power Jets W2/700 turbojets.

Now in production...

the new Hartzell Plastic
HYDRO-SELECTIVE PROPELLER
for personal planes

√ hydraulic controlled

A simple push-pull button on the instrument panel controls the pitch. Simple design control valve with only one moving part; hydraulic mechanism does not revolve. Blades automatically return to high pitch in event of oil pressure failure.

√ completely reversible

Complete reversal is achieved in a few seconds. Foolproof because the reversing lever is separate from the panel control.

√ pre-selective valve control

A calibrated valve control pre-selects the amount of pitch variation. Simply set the control and pitch change is automatic and precise.

√ hartzite plastic blades

Blades are of Hartzite plastic — weather-proof through and through. Hartzite is lightweight yet has the highest fatigue strength-weight ratio and highest vibration-damping qualities of any propeller material yet developed. Stainless steel tips.

√ highest quality — low cost

The materials and engineering in this propeller are of the highest quality. Yet, because the design and construction are so simple, the initial cost is low. Long life means minimum maintenance cost.

√ caa approved

CAA approved for planes up to 215 HP, 2600 RPM.

BUILT ON HONOR
HARTZELL
HARTZELL PROPELLER CO.
PIQUA, O. U.S.A.

Because of heavy demand for this propeller from plane manufacturers, deliveries to plane owners for replacements may not be possible for some time. ***Available on REPUBLIC SEABEE***

HARTZELL PROPELLER CO.

DESIGNERS AND MAKERS OF AIRPLANE PROPELLERS AND ENGINE TEST CLUBS

480 HEITZMAN AVE., PIQUA, OHIO, U. S. A.

F

WILLIAM H. KLENKE, Jr., has been named mgr. of Consolidated Vultee's N. Y. office. Formerly asst. sales mgr. for Vultee Aircraft, he returns to company after serving 4½ yr. in USMCR. He held rank of lieutenant-colonel. His office will be at 420 Lexington Ave.

THOMAS I. CASE has been appointed asst. domestic sales mgr. for Piper Aircraft. With company since '37, he was instrumental in interesting Army in use of lightplanes. He has been a pilot for 9 yr., and during war he served as lieutenant in Naval aviation.

CLARENCE O. BELL, veteran pilot and member of Goodyear Tire & Rubber Co.'s Aviation Products Div., has been awarded Litchfield Medal for outstanding work in developing and introducing aeronautical products. A flyer since '23, he has been with firm 17 yr.

JAMES L. GREEN has been named regional sales mgr. for Convair's Stinson Div. He was formerly associated with company's Washington office. His territory includes New England and Central Atlantic states. His hq. will be in N. Y. He joined company in '40.

DONALD W. HART has been appointed district sales mgr. for Northwest Div. of EAL. He was formerly city mgr. for company's Indianapolis office. A graduate of DePauw University, he has been associated with airline since '40, joining as sales representative.

JOSEPH A. YOUNG has been appointed operations mgr. for C&S. Associated with airline for 11 yr., he was formerly a test pilot for C-W and at one time was mgr. of Little Rock Municipal Airport. He was also associated with Eagle Aircraft.

RUSSELL DE YOUNG has been appointed vice-pres. and gen. mgr. of Goodyear Aircraft, where he was formerly vice-pres. in charge of production. He joined company in '28. A graduate of Akron University, he holds a B.S. in industrial engineering.

R. E. S. DEICHLER has been appointed vice-pres., sales, for American Airlines, where he was formerly vice-pres., administration. He served in war as a colonel, receiving Legion of Merit for administrative and organization developments he pioneered in AAF.

STEPHEN M. TRUEX has been appointed Turco Products field service representative for eastern aircraft companies and airlines. He was formerly connected with Pratt & Whitney Div. of United Aircraft Service Corp. His hq. will be at company's N. Y. office.

MALCOLM P. FERGUSON has been elected pres. of Bendix Aviation, where he had been vice-pres. and director. A graduate mechanical engineer of Syracuse University, he previously worked for Eclipse Machine Co. He is a member of IAS and SAE.

FELIX WAITKUS has been appointed to Boeing's sales department. Formerly a major in AAF, he was a member of AAF resident representative's staff at Boeing, and tested more than 1,000 B-17's and over 100 B-29's. He gained recognition in '35 as one of the early Atlantic nonstop flyers.

DR. JOHN H. FREDERICK has been appointed professor of Transportation & Foreign Trade in College of Business & Public Administration at University of Md. He will also be connected with Glenn L. Martin Institute of Aeronautical Research. He is author of book, "Commercial Air Transportation."

PHILIP M. WILLCOX has been elected vice-pres. of TACA. In commercial aviation field since '30, he has been associated with Stout Air Lines and was formerly vice-pres. of UAL. In his new position, he will administer planning activities of airline in Latin America, with hq. in Miami. (Affiliated Photo-Conway)

LESLIE A. BRYAN has been named director of Institute of Aeronautics, University of Ill. He will coordinate all activities of University in field of aeronautics, and also take charge of school's airport. He will also be a professor in College of Commerce & Business Administration at university.

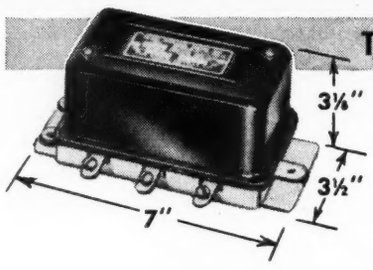
C. C. "CHET" PEARSON has been named eastern representative and asst. to pres. of Douglas. Associated with company since '30, he served as project engineer on several military models, including B-18 and B-23. Previous to new position, he was mgr. at company's Okla. plant. His hq. will be in N.Y.

Vital Statistics

OF A SENSATIONAL NEW GENERATING SYSTEM ANNOUNCED BY *Leece-Neville*

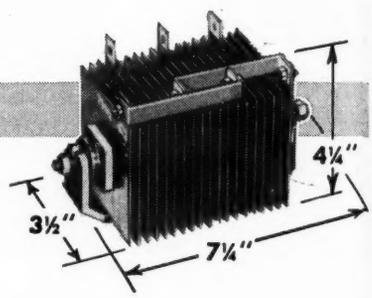
Part One
SIZES
WEIGHTS
RATINGS

THREE ELEMENT VOLTAGE REGULATOR



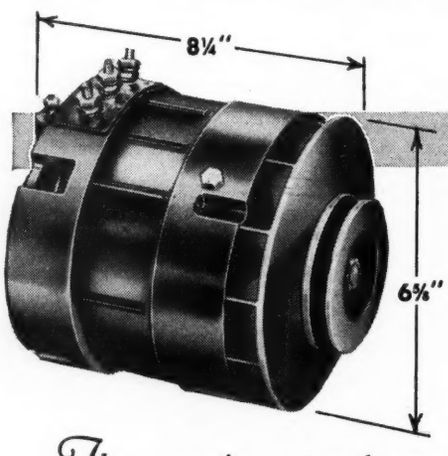
WEIGHT . . . . . 2½ Pounds
RATING . . . . 6 Volts—60 Amperes

RECTIFIER



WEIGHT . . . . . 6½ Pounds
RATING . . 6 Volts—60 Amperes

ALTERNATOR



WEIGHT . . . . . 31 Pounds
RATING . . . . 6 Volts—60 Amperes

★ Similar 3-unit system available for 12 volt service. RATING: 100 Amperes, 1500 Watts. SYSTEM WEIGHT: 45 pounds. ★

The generating system thousands have been waiting to see materialize! Delivers much greater output than conventional D-C generators—at low speeds as well as high speeds. Minimizes battery drain at idle or slow speeds by supplying all or a portion of load requirements. A source of greater power for electrical accessories that saves battery maintenance, prolongs battery life. Write today for bulletin giving complete details. *The Leece-Neville Company, Cleveland 14, Ohio.*

LEECE-NEVILLE

Pioneer and STILL Quality Leader

GENERATORS • VOLTAGE REGULATORS • SWITCH RELAYS • PUMP MOTORS

NEW PRODUCTS

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Products and Practices

INFORMATION TIPS

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ENGINEERING DATA

Retaining Rings 1

Catalog No. 4 from **Waldes Kohinoor**, Long Island City, N. Y., gives technical data, comparative material characteristics, critical dimensions, thrust loads, and impact tests of retaining rings.— **AVIATION, July, '46.**

Ball Bearings 2

Specifications on sizes and load ratings and types of applications of split race, ball, roller, and thrust bearings are given in Catalog No. 84 issued by **Split Ballbearing Corp.**, Lebanon, N. H.—**AVIATION, July, '46.**

Hydraulic Accumulators 3

Describing types and applications, bulletin from **Greer Hydraulics**, Brooklyn, N. Y., also contains performance data on line of hydraulic accumulators—**AVIATION, July, '46.**

Protective Coatings.....4

Outlining variables affecting properties and performance of electrolytic tinplates, folder, "Organic Protective Coatings and Their Performance on Electrolytic Tinplates", has been published by **Watson-Standard Co.**, Pittsburgh, Pa.—**AVIATION, July, '46.**

Stress Analysis 5

New folder from **Eastman Kodak Co.**, Rochester, N. Y., "Photoelastic Stress Analysis", gives survey of photographic aspects of stress analysis including optical theory, apparatus, photographic materials, and analysis of information obtained.— **AVIATION, July, '46.**

Worm Hobs 6

New listing issued by **Brad Foote Gear Works**, Cicero, Ill., contains dimensions on line of worm gear hobs available to customers.—**AVIATION, July, '46.**

Aircraft Landing Gear.....7

Containing technical and engineering data, three new brochures from **Dowty Corp.**, New York City, describe liquid springing, aircraft hydraulic units, and levered suspension undercarriages.—**AVIATION, July, '46.**

Broach Sharpening 8

Bulletin from **Lapointe Machine Tool Co.**, Hudson, Mass., gives technical information and rules for sharpening broaching tools. —**AVIATION, July, '46.**

Industrial Electronics 9

Explaining fundamental functions of electronic tubes, booklet, "The Business Man's Guide to Electronics" has been issued by **Westinghouse Electric Corp.**, Pittsburgh, to show how electronics may be applied to industry.—**AVIATION, July, '46.**

Cleaning Methods 10

Bulletin No. AS-364 issued by **Turco Products**, Los Angeles, covers field of aircraft cleaning, including paint stripping, parts cleaning, steam cleaning, and cleaning interior and exterior finishes.—**AVIATION, July, '46.**

Special Purpose Machinery.....11

Brochure from **Fuller Brush Co.**, Hartford, Conn., describes company facilities for designing and building semi-automatic and automatic special purpose machinery. —**AVIATION, July, '46.**

PRODUCTION

Drilling 12

Designed to increase drilling speeds, new "Jet" drill is described in Bulletin No. J-2 issued by **Republic Drill & Tool Co.**, Chicago.—**AVIATION, July, '46.**

Electrode Holders 13

Describing line of electrode holders, new 12-page catalog has been issued by **Tweco Products Co.**, Wichita, Kan., giving specifications and technical data.—**AVIATION, July, '46.**

Hardening Equipment 14

Including equipment for gear hardening, hardening internal and external rounds, and flat surface hardening, Catalog No. 90 from **Air Reduction Sales Co.**, New York City, describes firm's line of portable flame hardening apparatus.—**AVIATION, July, '46.**

Tool Sets 15

Containing information on veterans' procedure for obtaining tools under apprentice training program, Bulletin No. 4624 from **Plomb Tool Co.**, Los Angeles, describes two sets of tools offered.—**AVIATION, July, '46.**

Lead Comparators 16

Designed for use on production floor, two new lead comparators for checking helices on internal and external helical gears and worms are described in new Bulletin No. 1200-46 just issued by **Michigan Tool Co.**, Detroit. Model 1200 is for helices up to 45 deg. and Model 1200A is for angles above 45 deg.—**AVIATION, July, '46.**

Tube Fittings 17

Incorporating a heat treated steel sleeve with rear end slotted to form spring fingers, new tube fitting, "Grip Tube", is described in Catalog No. 101 offered by **Flodar Corp.**, Cleveland.—**AVIATION, July, '46.**

Instrument Testers 18

Bulletins issued by **Ideal Laboratory Tool & Supply Co.**, Cheyenne, Wyo., describe four-speed turn-and-bank tester and oscillating table for testing gyro aircraft instruments.—**AVIATION, July, '46.**

Pneumatic Tools 19

Keller Tool Co., Grand Haven, Mich., announces new catalog describing line of pneumatic tools, including sawing and filing tool, impact wrench, and air hoists up to ½-ton capacities.—**AVIATION, July, '46.**

Blind Rivets 20

Booklet "I'm Always Getting Into Other

AVIATION READER'S SERVICE — JULY 1946

Please send me additional information on item indicated (write number in circle) ◯

Company Name .....

Address .....

Your Name .....

Your Title .....

AVIATION, 330 West 42nd St., New York 7/46

Please send me additional information on item indicated (write number in circle) ◯

Company Name .....

Address .....

Your Name .....

Your Title .....

AVIATION, 330 West 42nd St., New York 7/46

Please send me additional information on item indicated (write number in circle) ◯

Company Name .....

Address .....

Your Name .....

Your Title .....

AVIATION, 330 West 42nd St., New York 7/46

Please send me additional information on item indicated (write number in circle) ◯

Company Name .....

Address .....

Your Name .....

Your Title .....

AVIATION, 330 West 42nd St., New York 7/46

People's Business, published by B. F. Goodrich Co., Akron, outlines uses of its "Rivnut", a one-piece blind rivet and blind nut plate combination.—AVIATION, July, '46.

Decalcomania Selector 21

On request, Meyercord Co., Chicago, will send to manufacturers, product designers, and purchasing agents new slide rule type decalcomania selector to assist them in specification of correct type of decal nameplate, trademark, or instruction for application on unusual surfaces.—AVIATION, July, '46.

Mycalex 22

Containing lists of properties, available types, molded parts, fabricated parts, and machine practice, new booklet published by General Electric Co., Pittsfield, Mass., also compares mycalex with other materials.—AVIATION, July, '46.

Coating Described 23

Folder from Geo. R. Mowat Co., New York City, describes "Klearlak", a protective coating for wood, metal, or cement surfaces, and lists uses.—AVIATION, July, '46.

Equipment Catalog 24

New catalog from Precision Equipment Co., Chicago, covers line of industrial equipment, including mill supplies, portable tools, work benches, cabinets, and drawing instruments.—AVIATION, July, '46.

Parts Booklet 25

Eaton Mfg. Co., Cleveland, announces new parts catalog dealing with aircraft engine parts such as valves, valve seat inserts, and rotor pumps for lubrication systems.—AVIATION, July, '46.

Welding Rods 26

Packaged for small users who need general utility rods, line of shielded arc welding electrodes is announced by McKay Co., Pittsburgh.—AVIATION, July, '46.

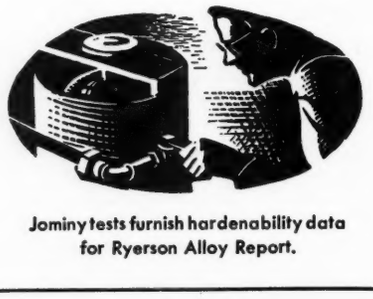
Soldering Iron 27

Developed for use on production lines, P-150 is new soldering iron announced in folder from Hexacon Electric Co., Roselle Park, N. J.—AVIATION, July, '46.

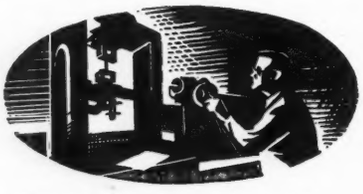
Inspection Plate 28

Made in either 4 or 12 in. dia. work capacities, new taper inspection plate is described in Bulletin No. 50161 issued by Ex-Cell-O Corp., Detroit, Mich.—AVIATION, July, '46.

Ryerson identifies every alloy bar with heat symbols and color marks.



Jominy tests furnish hardenability data for Ryerson Alloy Report.



Physicals interpreted from hardness readings are checked by tensile test.

Inspection assures accurate shipment of steel exactly as ordered.

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With every alloy shipment from Ryerson stocks you receive a positive performance record of your steel, because a Ryerson Alloy Report accompanies every shipment. This Report contains charted results of four Jominy hardenability tests plus the obtainable physical properties for various sized rounds of your particular heat of steel.

Chemical analysis and recommended working temperatures are also included and each Report is keyed with the heat identification number of the steel to which it refers.

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Principal Products: Alloys • Allegheny Stainless • Hot and Cold Rolled Bars • Structurals • Plates • Sheets • Tubing • Machinery & Tools, etc.

RYERSON STEEL

MACHINERY & ACCESSORIES

Milling and Boring Machines.....29

Catalog No. E-53 issued by Kearney & Trecker Corp., Milwaukee, presents line of milling and boring machines, accessories, and allied products, with specifications and dimensional data included.—AVIATION, July, '46.

Brakes 30

Designed for use on cranes, hoists, and mill machines, type "SW" brakes are described in literature issued by Victor R. Browning & Co., Willoughby, Ohio.—AVIATION, July, '46.

Casting Cleaning Machine.....31

Construction features, dimension drawings and specifications of new "Wheelabrator Tumblast" (airless blast equipment for cleaning castings) are contained in Catalog No. 264 published by American Foundry Equipment Co., Mishawaka, Ind.—AVIATION, July, '46.

Linear Dividing Machine.....32

Designed for automatic ruling of linear scales in either inch or metric systems, linear dividing machines are shown in Bulletin No. 153-64 issued by Gaertner Scientific Corp., Chicago, Ill.—AVIATION, July, '46.

Coolant Cup 33

Using gravity feed, new coolant cup designed for use on metal cutting machines is described in catalog page from Tru-Punch Co., New York City.—AVIATION, July, '46.

Lathe Attachment 34

Developed to produce small parts automatically on lathes, new "Dunamatic" lathe attachment is described in bulletin from Dunn Engineering Co., Detroit.—AVIATION, July, '46.

Chucking Machine 35

Developed for turning operations on castings, forgings, and tubing parts up to 12-in. dia., new single spindle "Chuck-Matic" is described in Bulletin No. SC-46 published by National Acme Co., Cleveland.—AVIATION, July, '46.

Hydraulic Units 36

Bulletins from John S. Barnes Corp., Rockford, Ill., describe hydraulic pumping units, one with capacity of 5 gpm. and 500 psi., another with capacity of 12½ gpm. and 1,000 psi.—AVIATION, July, '46.

Weight Measuring Unit.....37

Developed as a remote indicating dynamometer, "Tens-O-Trol", presented in literature from W. C. Dillon & Co., Chicago, is useful in aircraft field for testing wing loading and other stresses.—AVIATION, July, '46.

Flexible Shaft Grinder.....38

Information is available from Dumore Co., Racine, Wis., on new flexible shaft grinder designed to get into small corners, weighing 8 lb. and equipped with a 1/15 hp. motor.—AVIATION, July, '46.

Die Grinder 39

Having a maximum speed of 25,000 rpm, new air operated rotary file and die grinder presented in folder from Ideal Industries, Sycamore, Ill., weighs 16 oz. and is rated at ¼ hp.—AVIATION, July, '46.

Tube End Forming Machine.....40

Beading, flaring, flanging, expanding, reducing, double lap flaring, and flanging of ends of tubing ranging from ⅛ to 1 in. dia., are operations which new bulletin from Vaill Engineering Co., Waterbury, Conn., states can be done on company's No. 6 tube end forming machine.—AVIATION, July, '46.

ELECTRICAL

Thermostats and Pressure Switches..41

Containing technical, engineering, and dimensional data, catalog issued by United Electrical Controls Co., Boston, shows line of thermostats and pressure switches.—AVIATION, July, '46.

Frequency Meter 42

Developed to measure frequency of a.c. voltages over audible frequency spectrum, new frequency meter described in literature from Communication Measurements Laboratory, New York City, can also be used as electronic tachometer.—AVIATION, July, '46.

Strain Gage Indicator.....43

Information is available from Statham Laboratories, Los Angeles, on Model RD strain gage indicator, intended for measurement of strain in conjunction with standard resistance wire strain gages. By use of six sets of binding posts and gage selector switch, it is designed to enable successive readings from six strain gages which may be attached to various parts of a complex structure.—AVIATION, July, '46.

Radio Equipment 44

Issue No. 3 of "Western Electric Oscillator" published by Western Electric Co., New York City, contains article describing use of ARC-1 transmitting and receiving unit by commercial airlines in changing over to VHF (very high frequency) transmission.—AVIATION, July, '46.

Circuit Tester 45

Precision Apparatus Co., Elmhurst, N. Y., announces portable multi-range a.c.-d.c. industrial circuit tester, Series 856-J, designed to test various types of electrical circuits.—AVIATION, July, '46.

Solenoid Valve 46

Bulletin No. 462 from Allied Control Valve Co., South Norwalk, Conn., describes new solenoid valve for use with air, alcohol, water, or hydraulic fluid, and with a maximum pressure of 150 psi.—AVIATION, July, '46.

Air Valve 47

Information is available from Ross Operating Valve Co., Detroit, on new piston-poppet pilot-operated solenoid air valve, which is stated to allow operating speeds up to 400 cycles per second at 1.2 amp., 110v., and 60 cycles.—AVIATION, July, '46.

Insulation Resistance Meter.....48

New portable, self-contained insulation resistance meter, stated to test to 50,000 megohms, is described in Bulletin No. 210 issued by Associated Research, Chicago.—AVIATION, July, '46.

STEEL

Electrode Correlation Chart.....49

Data sheet from Arcos Corp., Philadelphia, lists stainless steels by trade name with proper alloy electrode for welding each, together with metal chemical analysis of each electrode.—AVIATION, July, '46.

Stainless Steel Listings.....50

Listing both former and present trade names of stainless steels of leading producers, new booklet issued by Rustless Iron & Steel Div., American Rolling Mill Co., Baltimore, also gives hardenability, Austenitic and Martensitic qualities, and machinability.—AVIATION, July, '46.

Safety Tools 51

Recommended for use in presence of explosive liquids, fumes, gases, and dust to prevent accidents which might be caused by sparks from steel tools, is line of tools shown in Catalog No. 117 from Ampco Metal, Inc., Milwaukee.—AVIATION, July, '46.

PLASTICS & SYNTHETICS

Testing Plastics 52

Designed as a guide to industry in setting up performance tests on plastic parts, new booklet, "Testing Plastics Parts," Advance Chapter No. 4, has been published by Society of the Plastics Industry, New York City.—AVIATION, July, '46.

PLANT SERVICE

Hand Truck 53

Made of cast magnesium alloy and weighing 26.6 lb., new hand truck is described in folder from Magnelux Mfg. Co., Los Angeles.—AVIATION, July, '46.

AIRCRAFT & ACCESSORIES

Hydraulics 54

Vol. 10, No. 10 issue of "Sperryscope", published by Sperry Corp., New York City, contains article "Hydraulics Serves Airlines" which describes application of various types of hydraulic equipment to commercial aircraft.—AVIATION, July, '46.

Collapsible Seats 55

Information is available from Evans Products Co., Detroit, on metal tube and canvas collapsible seat, developed for quick conversion of cargo planes to passenger carrying and ambulance work.—AVIATION, July, '46.

Engines 56

Containing specifications and operational data, new bulletin from Continental Motors Corp., Muskegon, Mich., describes line of aircraft engines ranging from 65 to 185 hp.—AVIATION, July, '46.

Instruments 57

Folder from Kollsman Instrument Div., Square D Co., Elmhurst, N. Y., gives speci-

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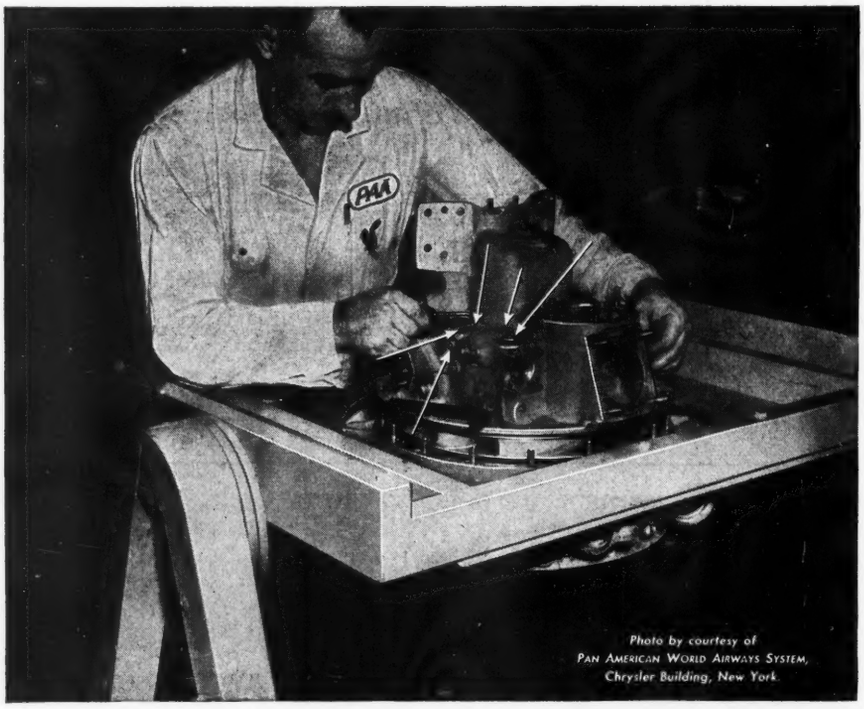

Photo by courtesy of
PAN AMERICAN WORLD AIRWAYS SYSTEM,
Chrysler Building, New York.

ALLEN

Hex-socket (hollow) Set Screws used in connection with critical adjustments in the accessory end of an airplane engine. This photo of an overhaul job was taken in the Miami maintenance base of the Pan American World Airways System.

The company observes that in this particular application, "where quality and dependability are very necessary factors, the contribution of Allen Products has been noteworthy". There are countless other applications in planes and in plants that *make* the planes, where "Allens" hold together mechanical assemblies with that never-let-go-tenacity dramatized in the air.

ALLENS have strength for set-ups with weld-like grip, not to be budged by shock-stresses or sustained vibration. Thread tolerances are held to a high Class 3 fit, for a high degree of frictional holding-power... Screws cold-drawn and *"pressur-formd"* of special-analysis ALLENOY steel, heat-treated under scientific controls. Hexagon sockets handily reached with Allen Hex Keys in the hardest-to-get-at places. Adapted to high-speed assembling with power drivers.

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Allen Hex-socket Screws and "Tru-Ground" Dowel Pins supplied only through Industrial Distributors in all centers.

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fications and description of line of aircraft instruments for private planes, including altimeters, airspeed indicators, compasses, climb indicators, tachometers, and manifold pressure gages.—**AVIATION, July, '46.**

AIRPORTS

Fuel Handling Equipment.....58

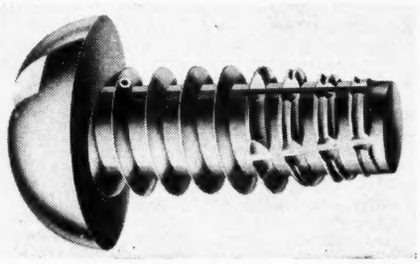
Describing three basic types of pumping systems, dispensing pumps, motorized equipment, and accessories, new catalog of fuel handling equipment for airports has been issued by **S. F. Bowser & Co.**, Fort Wayne, Ind.—**AVIATION, July, '46.**

NEW·PRODUCTS

Shop Equipment & Materials

Self-Tapping Screw.....59

Combining thread cutting characteristics and coarse pitch of company's other screws, new type "F-Z" self-tapping screw has been designed by **Parker-Kalon Corp.**, New York City, for making fastenings to thin section and bosses in friable



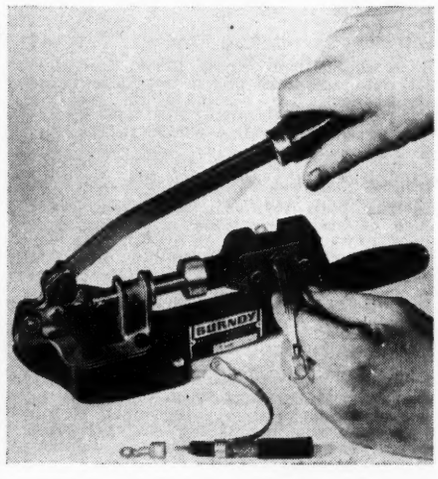
and brittle plastics. Five cutting flukes distribute cutting pressure. Coarse threads are stated to eliminate binding by acting as a reservoir for displaced material and to offer greater resistance to stripping out of material.—**AVIATION, July, '46.**

Torque Screw Drivers.....60

Airdraulics Engineering Inc., New Canaan, Conn., announces new "Tru-Torque" line of torque measuring and controlling screw drivers. Of friction disk type, they are made in three sizes giving from 0 to 25 lb.-in. torque. To operate, tool is preset at desired torque; operator tightens fastening, and when desired torque is reached, handle slips and no further tightening is possible. Screw drivers are made with one regular blade for slotted screws, nuts, or bolts; one Phillips type blade; one Allen wrench and pin setter. Snap-on adapter is also available.—**AVIATION, July,**

Cable Connector Tool 61

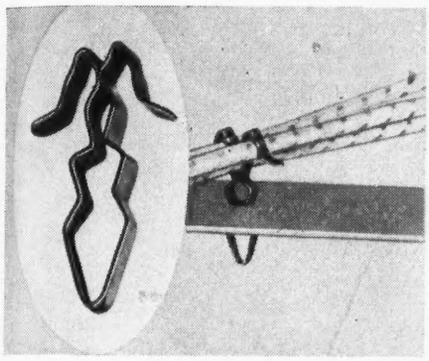
Burndy Engineering Co., New York City, announces new portable, manually operated



tool for installing coaxial and shielded connectors. Known as "Hytool", it is stated to accommodate all standard die sets designed for use with company's foot-operated and power-actuated units. Removable dies in tool are located to allow cable and connectors to be readily inserted and located. Connection is made by single stroke of tool. Reduction of fatigue is reported accomplished by high mechanical advantage of lever.—**AVIATION, July, '46.**

Insulated Wire Clip.....62

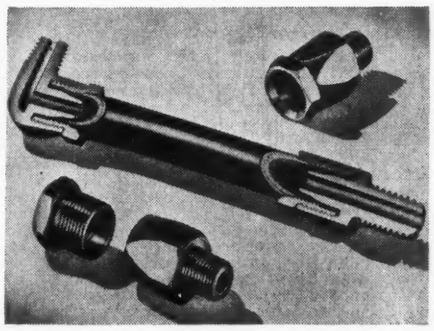
Designated as A3493-1, and holding two to three parallel insulated wires, new spring steel clip, made by **Tinnerman Products,** Cleveland, is for assembly of wiring in air-



craft. It locks itself into place ready to receive wires, which are assembled by pushing them into clip. Damaged wires can be replaced without tools. Clip fits in panels from .025 to .064 in. thick and holds three No. 16, 18, or 20 insulated wires.—**AVIATION, July, '46.**

Hose Couplings 63

For hand assembly of hose lines, new two-piece safety seal couplings, developed by **Resistoflex Corp.,** Belleville, N. J., are attachable-detachable, reusable metal couplings suitable for aircraft oil and fuel lines. Coupling nut threads onto hose, with coupling shell compressing hose end into sealing gasket. With special threads, fitting has



long grip on hose, double-bell shape allowing hose to flex without cutting. Heavy body of fitting is stated to prevent distortion or crushing of line.—**AVIATION, July, '46.**

Permanent Magnet Materials.....64

Having applications in manufacture of aircraft instruments, five new permanent magnet materials, known as cunico, cunife, vectolite, alnico 12, and silmanal, are announced by **General Electric Co.,** Schenectady, N. Y. Cunico magnets are an alloy of copper, nickel, and cobalt and are made from rod, strip, or wire stock. They are furnished in their final shapes as they are age hardened in manufacturing process. Material is malleable, ductile, and machinable. Cunife is a copper, nickel, and iron alloy, similar to cunico, but it has directional properties and must be magnetized along direction material has been cold-worked to obtain highest magnetic quality. These magnets are made from wire stock in round, square, or rectangular form. It can also be flattened to make thin, narrow shapes. Vectolite is stated to be first non-metallic non-conducting magnet material made. It is a hardened, sintered combination of iron rust and cobalt oxide mixed when in powdered form. Non-conductive properties are said to prevent electrical losses caused by conduction of current. Alnico is made of aluminum, nickel, cobalt, iron, and titanium. Material is cast and

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For ordinary combustible materials, wood, paper and textiles, a Pyrene Water-Type extinguisher fills the requirement. Operated by a gas cartridge, it is standard for offices, buildings, plants and stores. For locations subject to freezing temperatures, Pyrene Anti-Freeze extinguishers are effective at —40° F. Neither type requires annual recharging.

Standardize on Pyrene Protection. Control of fire in all its phases has been Pyrene's business for almost 40 years. There are specific Pyrene Fire Extinguishers for different classes of fires. A Pyrene jobber will be glad to help you determine your fire hazards and advise best methods for protection from them.

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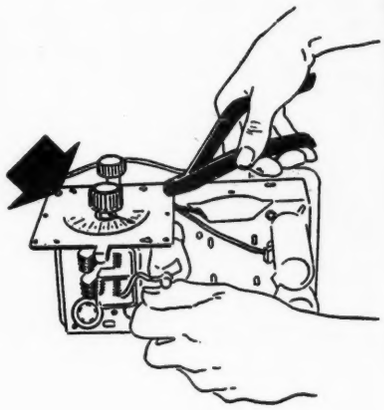
ground to shape. Silmanal, stated to have high intrinsic coersive force, is ductile and malleable and can be punched, machined, rolled, or ground. It can be made in rod, strip, or wire form.—**AVIATION, July, '46.**

Blind Rivet Gun.....65

Made for small fastening jobs, new blind rivet gun has been added to line of blind riveting tools made by **Cherry Rivet Co.,**



Los Angeles. Made in grip three lengths, it is a one-hand plier-like tool that installs new 3/32 in. blind rivet of pull-through hollow type.—**AVIATION, July, '46.**

Roller Bearing 66

Designed to carry heavier loads at higher speeds and lower temperatures, new type roller bearing announced by **SKF Industries,** Philadelphia, is expected to facilitate wind tunnel operation for research into such projects as gas turbine and jet propulsion speeds and designs. Bearings' self-aligning principle compensating for shaft deflection, distortions, or weaves, is to permit heavy loads to be distributed over all rollers. Other features are new design for lubrication and cage retaining sleeve pressed into bore of inner ring, making a contained assembly of rollers, cage, and inner ring.—**AVIATION, July, '46.**

Dipping Basket 67

To aid in use of cold immersion type cleaner in removing deposits from aircraft engine parts, **Bendix Products Div., Bendix Aviation Corp.,** South Bend, Ind., offers cleaner with metal parts dipping basket.—**AVIATION, July, '46.**

Bench Drill 68

Designed for use in fabrication of small parts of metal, wood, or plastic items, new lightweight high-speed bench drill is announced by **Dumore Co.,** Racine, Wis. Drill head is held in desired position on steel column with locking device. This holds motor in place, and permits vertical adjustments and 360 deg. radius of action. Table, similarly mounted, is elevated to drill by hand control geared to table. Power is 1/30 hp. motor with range of 2,000 to 15,000 rpm. Speed control is by foot rheostat. Weight is 15 lb.—**AVIATION, July, '46.**

Clamping Jig 69

Utilizing braking power of mated male and female cones, new pump clamping jig to hold small parts is made by **N. A. Woodworth Co.,** Detroit. Working parts are hardened-and-ground alloy steel. Moving parts operate in oil bath, keeping chips and cutting oils from contact with internal parts. Safety features: Elimination of movement of working parts without action of operating lever; also clamping of tray at any location in up or down strokes so that any sudden weight or pressure applied to tray throws second lock, securing tray at original position. Jig sizes available are for working spaces 1x1x1 in. and 1x2x1 in.—**AVIATION, July, '46.**

Acoustical Insulation 70

Composed of glass fibers, with average dia. of 0.00005 in., lightweight, non-combustable Fiberglas thermal and acoustical insulation material, made by **Owens-Corning Fiberglas Corp.,** Toledo, Ohio, is now available for installation in civilian aircraft. Fibers are treated with thermosetting binder and shaped into flexible ½-in.-thick sheets 48 and 54 in. wide. Density is 0.6 lb. per cu. ft. Material comes in rolls

Small Tubing in a fabricated product often becomes lost to sight—nevertheless the ravages of corrosion go on and on.

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Superior Tube Company has long experience in the specification and production of corrosion resistant tubing to satisfy the demands of a wide range of destructive conditions resulting from exposure to corrosive fluids and atmospheres.

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Also beryllium copper, nickel, monel†, 'K' monel†, inconel†, Nichrome V, and other nickel alloys; 36%, 42%, and 52% Ni Iron.

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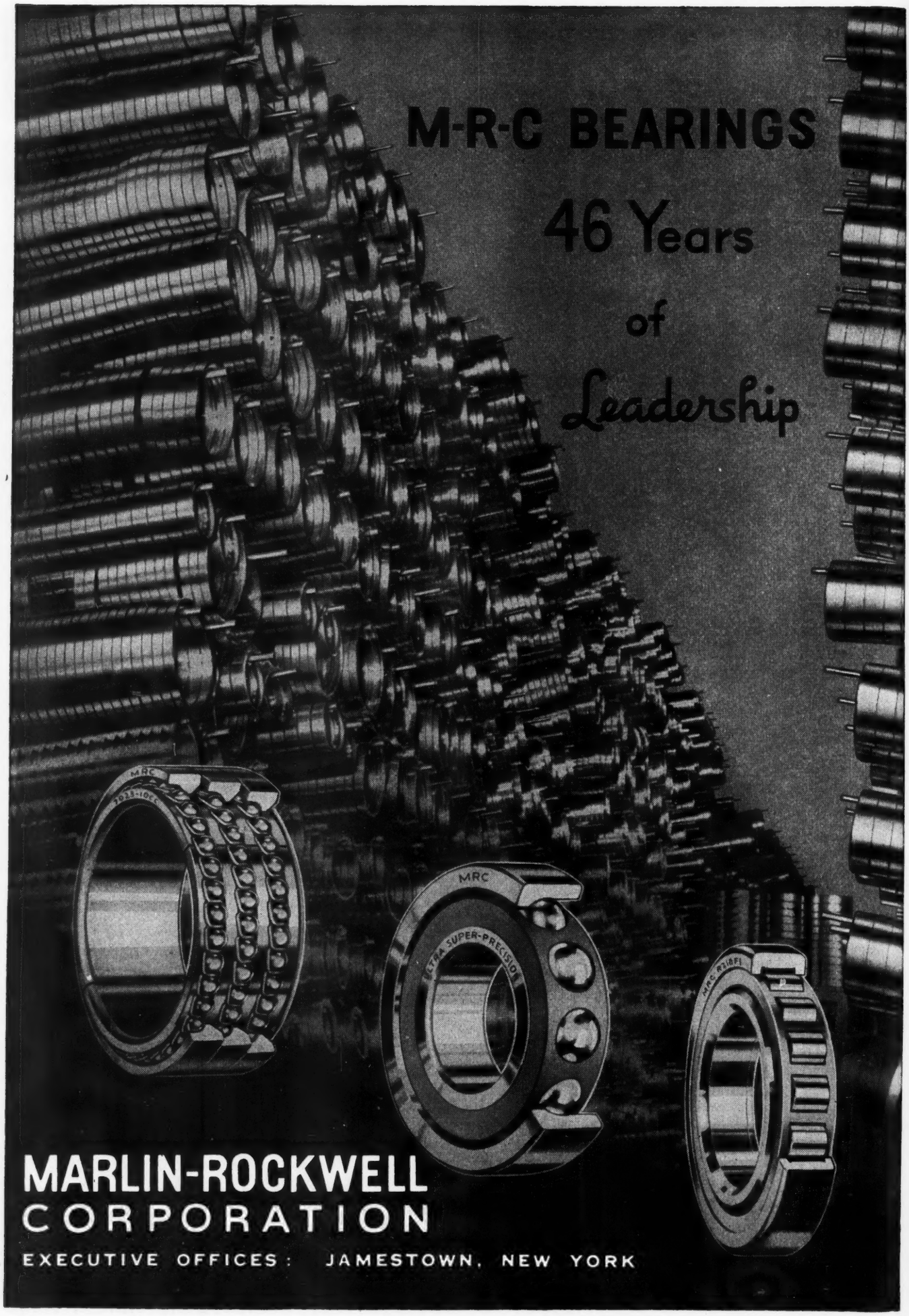
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50 ft. long. Thermal conductivity is stated to be 0.26 Btu. per sq. ft., per hr., per in. of thickness, per deg. temperature difference, at a mean temperature of 75 deg., heat capacity 0.005 Btu. per sq. ft., specific heat 0.20 Btu. per lb., and moisture absorption less than 1% by weight.—**AVIATION, July, '46.**

Circle Cutter 71

Developed to cut holes in wood, steel, brass, hard rubber, aluminum, fiber, and plastics, new hole cutting tool made by **Bruno Tools,** Beverly Hills, Cal., cuts holes any dia. from 1⅞ to 8 in. through ¼ in. thickness in steel and similar metals, and through 1½ in. thickness in plastics, fibers, or wood. Tool is designed to operate in any standard drill press or wood boring machine. Unit consists of combination drill and pilot with cutting blade, adjustable to depth and dia. Cutting-blade holder permits cutting edge to recede or yield from work while maintaining pressure and feed. Twin-blade holder with fixed ½ in. center cuts washers, wheels, disks, or gaskets.—**AVIATION, July, '46.**

Drawing Instrument 72

Working on stencil principle, new drawing board instrument, for use in machinery fields, is made by **Rapidesigns,** Glendale, Calif. Embodying templates for standard gears, rivets, drill points, countersink points, and various types of screw heads, it is made from transparent, laminated plastic sheets, with markings inlaid between laminations. Known as Model 250, it gives rivet and screw sizes from 3/32 to ¼ in., drill point and countersink angles 62, 78, 100, 118; involute gear teeth No. 10 to 2; and rack gear sizes 13 to 3. Size is 9 x 12½ in.—**AVIATION, July, '46.**

Manual Metal Cutting Tool.....73

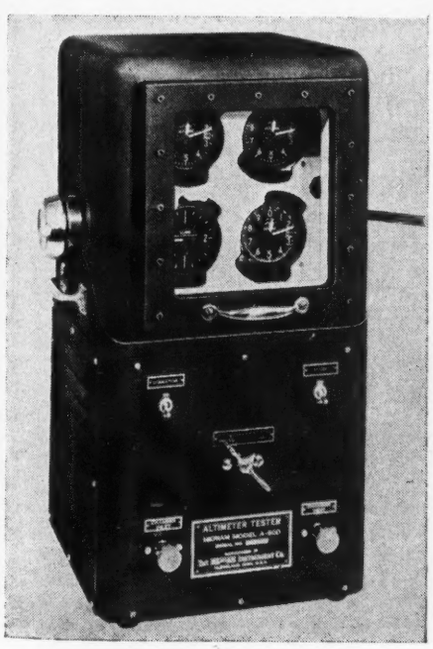
Suitable for use in aircraft manufacturing and repair shops where use of hand operated tool is needed, new metal shearing tool, "Nibbler", is made by **Brenning Mfg. Co.,** Cheyenne, Wyo. Cutting head is made of heat-treated, tempered steel. A one-hand plier type tool, it can be used for trimming or cutting away portions or particles that would require filing.—**AVIATION, July, '46.**

Tool Bit 74

Utilizing principle of molecular cleavage, new tool bit made by **Fearless Tool Co.,** Los Angeles, cuts metal with knifelike action instead of chiseling it off by rupture method. Shearing action is said to make possible depths of cuts up to three times nominal size of tool bit used. Tool is made to be used on copper, brass, bronze, plastics, cast iron, steel, and other ferrous and non-ferrous alloys, without changing original grind. Other reported advantages: Faster cutting speeds, lack of heat, and less wear on machine tools.—**AVIATION, July, '46.**

Altimeter Test Unit.....75

Consisting of chamber, integral pump,



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ONAN ELECTRIC GENERATING PLANTS provide power for many applications in the aviation industry. Available in 65 models including airborne, lightweight, compact types. Powered by Onan gasoline engines, they are of compact, single-unit designs. For heavy duty service, stationary or mobile.

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Capacity range: 350 to 35,000 watts; 115 to 660 volts A.C., 50 to 800 cycles; 6 to 800 volts D.C.; combination A.C.—D.C. types.

Write For Folder 690 describing complete Onan Line

Model shown is from W2C series: 2000 to 3500 watts, powered by Onan two-cylinder, water-cooled engine.

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41 years of continuous service with Allis-Chalmers Manufacturing Co. are convincing testimony to the value of Olaf Olson as a precision worker and master of his craft. 66 years of service to the manufacturers and skilled workers of America have made Starrett Tools the outstanding choice of buyers and users wherever precision measuring tools are used.

Photo courtesy Allis Chalmers Mfg. Co.

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Kidde Engineered Systems fire-protect *TODAY'S* planes and anticipate *TOMORROW'S*

HIGHER SPEEDS, larger engines- and more of them per plane. That means new problems in fire protection!

Kidde *engineered* extinguishing systems—planned for the plane—keep constantly in step with these new requirements. On many of the faster, larger planes that have already taken to the air, Kidde systems are helping to establish high standards of fire safety.

For revolutionary designs still on the drawing boards, Kidde engineers are prepared to develop equally effective, reliable extinguishing systems.

Aircraft manufacturers and transport companies are invited to discuss their fire protection problems with Kidde.

Walter Kidde & Company, Inc., 520 Main Street, Belleville 9, N. J.

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The word "Kidde" and the Kidde seal are trade-marks of Walter Kidde & Company, Inc.

Kidde

control valves, and electrical equipment, altimeter test unit, Model A-900, is offered by **Meriam Instrument Co.**, Cleveland, for testing altimeters and rate-of-climb indicators.—AVIATION, July, '46.

Ultraviolet-absorbing Plastic.....76

Developed to give protection to flyers in planes with transparent tops, new ultraviolet absorbing type of Lucite acrylic resin is announced by **E. I. du Pont de Nemours & Co.**, Wilmington, Del. This plastic sheeting, developed for use on warplanes, is being made in clear and green transparent sheets, offering anti-glare properties.—AVIATION, July, '46.

Machinery & Accessories

Die Casting Machines..... 77

Having hydraulically operated mold clamping, metal injecting, core pulling, and ejecting units, two new high pressure die casting machines for casting magnesium, aluminum, and copper alloys, are made by **Hydraulic Press Mfg. Co.**, Mount Gilead, Ohio. Employing cold chamber process, metal is sustained in molten state in holding furnace. Operator ladles metal into a slot opening into injection cylinder. Injection plunger advances, displacing metal in cylinder and forcing it into mold. Machines have injection capacities from 12½ to 100 cu. in. per cycle, and have injection pressures from 6,000 to 50,000 psi. Two models, 400-A for aluminum and 400-M for magnesium, are now being made. Magnesium machine has plunger actuated by a nitrogen accumulator providing injection speeds up to 7,200 in. per minute. Adjustable injection speed on this machine permits it to be used for casting other alloys. Aluminum machine uses straight-line hydraulics, injection ram being direct connected to radial pump. Maximum injection speed is 750 in. per minute.—AVIATION, July, '46.

Hydraulic Press 78

Rodgers Hydraulic, Inc., Minneapolis, announce new shop press of 60-ton capacity. Power is supplied by 2-speed hand pump which moves ram 2½ in. per pump stroke, giving 2,000 lb. pressure. Ram travel is 13 in. at continuous stroke. Maximum opening between bolsters is 38 in., minimum is 8 in. Working width between sides is 45 in. Longer pieces may be handled through open sides any place above globe valve and pump. Hydraulic pump, globe valve, and gage are calibrated in tons and pounds. Height is 88¾ in. and floor space is 38 x 70 in.—AVIATION, July, '46.

Tool Grinding Fixture 79

George Scherr Co., New York City, announces tool grinding fixture for grinding of lathe tools, screw machine form tools, shaper, planer, milling machine, or any angle cutting tools. Tool is placed on magnetic chuck of surface grinder and held in position by magnetic chuck. It is graduated up to 90 deg., and angles both right and left may be obtained. At same time, rake angle may be ground on tool by tipping block, which gives 3, 5, 7, and 10 deg. clearance. Device may be used to grind tools from ⅛ to 1¼ in. and is used for carbon, alloy, and tungsten carbide tool bits. Inside and outside threading, recess, and form tools may be ground.—AVIATION, July, '46.

Electrical Appliances

Electronics Connector 80

Developed for use in radio, radar, and other electronic devices, new type connector with built-in capacitors is available from **H. H. Buggie & Co.**, Toledo. It is made in either pressurized water-tight or non-pressurized types, pressurized units being tested to 30 psi. It has by-pass feature stated to filter undesirable frequencies from leads. Each pin is provided with by-

Save a Place for It in Your Private Plane

THE VHF Raytheon Radiophone

The VHF Raytheon Radiophone will bring to private plane owners all the advantages of VHF transmission, plus features found only in the Belmont-built Raytheon Radiophone.

Pilots are assured not only of reliable transmission on VHF channels, but they can receive signals on low frequency ranges also. Continuous coverage is provided in the low frequency range from 190 to 425 kc and 540 to 1600 kc, as well as the 75 mc channel.

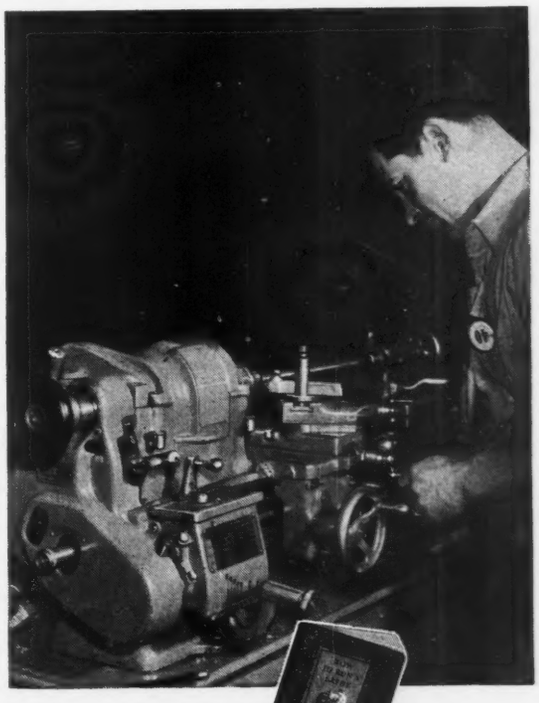
Pilots and owners are invited to investigate the VHF Raytheon Radiophone—now.

For ease of servicing, entire unit can be removed and replaced with another Radiophone in a matter of minutes. • Receiver performance comparable to commercial airline standards. • Crystal controlled transmitter never drifts off frequency. • Power output of transmitter ATR-10—4 watts. • Two vibrators operate independently—easily switched while in operation. • Height 5", width 5¼", depth 14¼". • Weight 14 pounds. • Equipped with range filter, push-to-talk microphone, transmitter output indicator, long life Raytheon Tubes and provision for direction finder loop. • Ample power for loud-speaker operation. • Stub antenna, only 21 inches high.

BELMONT RADIO CORPORATION
A Division of Raytheon Manufacturing Company • 5955 W. Dickens Ave., Chicago 39, Ill.

SOUTH BEND LATHES

PRECISION ACCURACY IN AIRCRAFT SERVICE



In servicing planes, one rigid requirement is precision accuracy. Every connection, every instrument, every gauge, thousands of parts in hydraulic systems and motors — all built with highest precision — must be serviced the same way. That's why South Bend Precision Lathes are so widely used in the aircraft industry — in factory and maintenance shops throughout the world.

"HOW TO RUN A LATHE"—This interesting book explains in detail how to operate a lathe and shows the wide variety of work that can be done on it. Contains 128 pages, 365 illustrations. Sent postpaid for 25c in U. S. coin or stamps.

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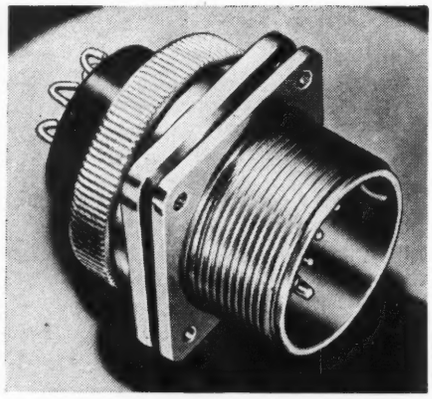


pass to aluminum shell at capacities from 50 to 1,800 micro-microfarads, 350 working volts, using ceramic capacitors. Unit is available in AN pin arrangements as well as arrangements to meet other specifications.—**AVIATION, July, '46.**

Electrical Connectors 81

Incorporating new type of inserts and grommets, made of "Scinflex", new electrical connectors made by **Scintilla Magneto Div., Bendix Aviation Corp.,** Sidney, N. Y., are interchangeable with AN connectors. Stated to be uneffected by vibration and shock (since there are no loose inserts or contacts and conductors are supported at solder well by grommets) connectors are stated to have high arc resistance and dialectric strength not less than 300v. per mil. Design increases flashover distance and precludes entrance of moisture, dirt, and explosive mixtures. Other features are ability to assemble and disassemble without disturbing insert, elimination of two-piece inserts with snap rings, and interchangeability and removal of socket and pin inserts.—**AVIATION, July, '46.**

Sealed Transformer Bushings.....82

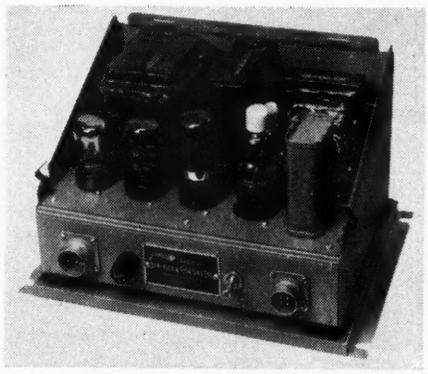
Made of steatite glazed permanently to stainless steel, hermetically sealed transformer bushings, in both multiple and single terminal styles, are now available, in wide range of current and voltage capacities, from **General Ceramics & Steatite Corp.,** Keasbey, N. J. Current capacities range from 1 to 20 amp. and voltage flashovers range from 2,000 to 40,000v. rms. Maker states component materials have been selected so combinations will withstand 20 cycles of thermal shock from minus 55 to plus 125 deg. C. and also take thermal shock of soldering into place on production line.—**AVIATION, July, '46.**

Cathode Ray Tube.....83

Designed for oscillographic and other applications requiring small, short tubes with high light output and deflection sensitivity, new cathode ray tube, 3JP, made by **Allen B. Du Mont Laboratories,** Passaic, N. J., is stated to be useful in equipment which must be operated under strong ambient light conditions. Focusing electrode current, under operating conditions, is small, and adequate insulation between electrode leads for high altitude installation is provided by 2 in. neck and diheptal base.—**AVIATION, July, '46.**

Voltage Regulator 84

Weighing 12½ lb., new 400 cycle aircraft line voltage regulator announced by **Sorensen & Co.,** Stamford, Conn., is stated to supply loads totaling 500 v.-amp. with voltage regulated to 0.2%. It can be used as voltage supply for aircraft instruments, automatic pilots, automatic engine controls, radio, and radar systems. Shock mounting is provided, transformer and reactor components are Fosterite impregnated, and fungicide treatment is used. There are no moving parts. Unit is said to maintain regulation within frequency range of 360 to 500 cycles per second and has adjustable output voltage from 110 to 120v., and input voltage varying from 95 to 125v.—**AVIATION, July, '46.**



Foundation Instrument.....85

Developed to permit user to assemble accurate instrument for use as voltmeter, milliammeter, high and low resistance ohmeter, a.c. voltmeter, and decibel meter, new foundation instrument is being made by **Marion Electrical Instrument Co.,** Manchester, N. H. Units are available in 3½, 4½, and 8½ in. sizes, and each size is interchangeable electrically. The basic sensitivity is 400 microamp. and internal resistance is 500 ohms. Scales are printed in 3 colors and cover 100 deg. Unit is stated to be suited for use as 2,500 ohm per volt or as 1,000 ohm per volt, as milliammeter, high and low range ohmeter, and as 1,000 ohm per volt a.c. voltmeter. Scales supplied include 0-10-50-250 a.c. and d.c. volts, 0-500 ohms and −10 to + 14 db. By use of multiplier, 0-10 voltmeter scale may be used as 0-1,000 v.—**AVIATION, July, '46.**

Water-Cooled Mica Capacitors.....86

Available for extra heavy duty service, such as in high-power transmitters, new Series 1780 water-cooled mica capacitors, made by **Aerovox Corp.,** New Bedford, Mass., are reported to boost kva. ratings by a factor of five or more. Higher ratings are said to be obtained in two ways—first, by critical arrangement and location of mica sections, critical selection of materials, specially designed parts, or large cross section of conductors; second, by use of water-cooling system designed to provide maximum heat transfer from capacitor section to cooling coils. Ratings range up to 25,000v. and capacitances up to .01 mfd.—**AVIATION, July, '46.**

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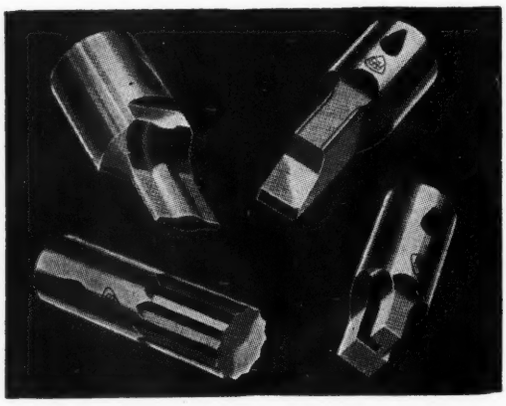

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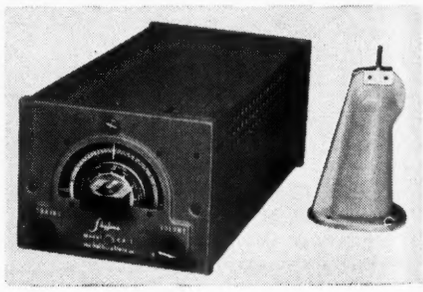
Aircraft Parts & Field Units

Radio Telephone 87

Designed for personal aircraft and known as "Skyfone" Model CA-2, new radio telephone made by **Hallicrafters Co.,** Chicago, weighs less than 8 lb., covers all frequencies of radio ranges, control towers, and beacons, and includes a broadcast band. With loud speaker optional, it features



three controls with separate dial scales, anti-noise microphone, and circuits designed to reject ignition interference.—**AVIATION, July, '46.**

Panoramic Reception Instrument.....88

Showing visually and simultaneously a panorama of frequencies, new system of reception announced by **Panoramic Radio Corp.,** New York City, known as panoramic reception is available in instrument called "Panadaptor". It may be attached to radio receiver having intermediate frequency of 450 to 470 kc. A band of frequencies 100 kc. on either side of frequency to which receiver is tuned is visible at all times. Band width is changed by knob on panel, so band is covered from 200 kc. to any width down to zero. In latter case, signal characteris-

Close-up showing main legs of Summerill Aircraft Tubing in landing gear assembly, Fairchild C-82 Packet. The large tapered sections may be seen protruding from beneath the wing in larger photo at right.

There's more than 10 tons dead load on each of the wheels in the main landing gear of this ship. Special Summerill Seamless Tube sections are supplied for the legs—a vital spot, where failure would cause disaster. (See engineers' note at bottom of page.)

This, of course, is in addition to the great variety of standard shapes and sizes used in the general construction of the Fairchild C-82 Packet—the flying boxcar. A glance at the picture of three men swinging the 15-foot propeller shows, by comparison, the giant size of the ship and helps explain that 10 tons dead load.

Many aircraft builders, large and small, rely on Summerill for seamless steel tubing—streamline, round or square sections, standard or special shapes. We've pioneered in this field—can now meet most any specifications.

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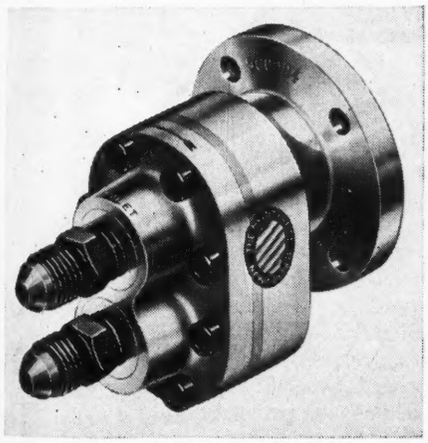
tics of station to which set is tuned may be studied in detail. All signals, of all types, within 200 kc. portion of spectrum are visible on screen of instrument. As receiver is tuned, new signals appear and old ones disappear. Weak signals can be seen under masking noise in noisy locations. Operator watches screen of instrument instead of radio dial when tuning. Transient signals and short calls can be seen and receiver shifted before they disappear. Four controls provide for compensation of receiver characteristics, gain, band width coverage, and center frequency control. Instrument is said to be useful for spotting weak or shifting stations, and for identifying types of signals before tuning in, since phone and cw. look different on screen. One application is in control tower use where, although receiver is left tuned to frequencies used by planes, there is possibility that plane transmitter might be off frequency enough to prevent its being heard by tower, but would show on screen and thus could be picked up.—**AVIATION, July, '46.**

Pressure Lubrication Pump.....89

Designed for pressure lubrication of machine tools, Diesel engines, and generators, and fluid handling in aircraft at high alti-



tudes, new direct drive gear pump, Series 1200, made by **The McIntyre Co.**, Newton, Mass., is an 8 oz. unit operating with a volumetric efficiency stated to be 95%. Three models displace from .08 to 1.5 gpm. at speeds ranging from 1,140 to 3,450 rpm. against pressures up to 150 psi. Units are designed for direct motor application, but can be furnished for flange mounting, belt, spline, or other drives. Pump body is constructed of aluminum, with nitrided nitralloy spur gears and shafts. Power required varies from 1/100 to 1/6 hp.—**AVIATION, July, '46.**

Aircraft Vacuum Cleaner.....90

Suitable for use in aircraft service shops, new jet type vacuum cleaner, designated the "Rocket," is designed for cleaning interiors, carpets, and upholstery of planes. Maker is **Management & Research,** Upper Darby, Pa. Cleaner weighs 1½ lb. and is 18 in. long. It operates on compressed air and has no moving parts.—**AVIATION, July, '46.**

Oil Refiner 91

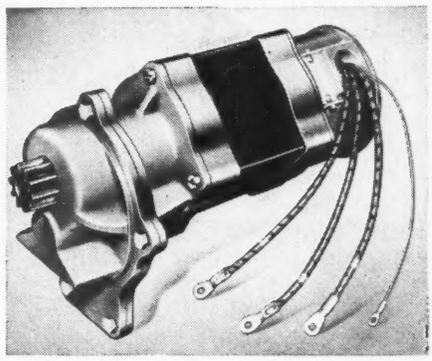
Adaptable for airports or air transport companies, new oil refiner designed to restore used lubricating oil to quality of new oil is announced by **Youngstown Miller Co.,** Belleville, **N. J. Unit** is said to remove both solid and dissolved impurities. Dirty oil is pumped to heating chamber under automatic float control. Adsorbent earth is added and combination is mixed by agitator and heated with electricity. Removal of volatiles is stimulated by evaporative effects of stream of fresh air which is passed across oil surface, permitting low operating temperatures. Heaters are under thermostatic control. Oil and earth mixture is dropped by operator to transfer tank, from which it is forced into two stage filter by air pressure. Here, solids including adsorbent materials are removed. Clean oil may be piped from filter press to storage facilities.—**AVIATION, July, '46.**

Surface Cleaner 92

Developed to clean glass, painted surfaces and metal surfaces without requiring rubbing and wiping, suitability is seen in aviation field for "Auto Wash" made by **Gaston Johnston Co., New York City.** Using ¾ oz. per gallon of water, it is stated to leave no spots or streaks.—**AVIATION, July, '46.**

Airplane Starter-Generator 93

Designed for lightplane applications, 17-lb. "Eemco" generator-starter, a direct drive combination unit for aircraft engines, is announced by **Electrical Engineering & Mfg. Co.,** Los Angeles. Starter



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LOCKHEED

The Wet Load

The first cargo carried by the *Constellation* was put aboard via a four-inch fire hose. It consisted of 8.8 tons of water. This doesn't sound like a very intelligent choice of payload, but under the circumstances it was.

When Lockheed engineers first took No. 61 (the test *Constellation*) into the air, they wanted to know how the ship reacted to shifts in its center of gravity. So they originated and installed a system of water ballast tanks. The interior of the cabin looked like a cross between a hardware store and an aquarium.

By merely turning various valves, engineers could shift a ton or two of load from here to there in flight. Much easier than lugging sandbags around, and a lot more accurate. And since flight test costs on the *Constellation* ran to about $6200 an hour, the system more than paid for itself by speeding up the whole test program.

This rig, another example of the old Lockheed moxie, proved to engineers that the *Constellation* is a remarkably stable plane. More so, in fact, than any other large transport.

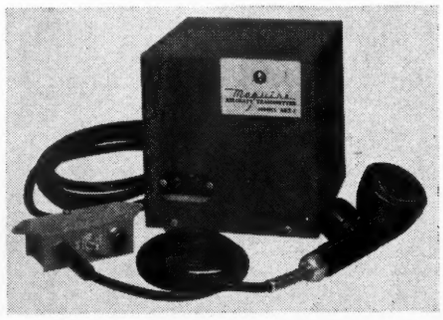
L to L for L

© 1946, Lockheed Aircraft Corp., Burbank, Calif.

and generator, having same windings, are combined in unit. Output of generator is 35 amp. at 14v. Starter gear reduction is 23 to 1, and generator reduction is 2½ to 1. Maximum starting torque is 160 lb.-ft. Generator output is 500w., continuous duty. Torque limiting clutch is built in to prevent damage from backfire. Unit is coupled to engine crankshaft. Length is 9½ in. —AVIATION, July, '46.

Aircraft Radio 94

Developed to meet lightweight, standard service requirements of private flyer, a new "Skyline" aircraft radio transmitter announced by **Maguire Industries,** Bridgeport, Conn., is also adaptable for standby service in larger commercial aircraft. Model ART-1 consists of an 8w. 3,105 kc. crystal controlled set with working range of from 15 to 30 mi. on a fixed antenna. Loading coil of antenna is adjustable for resonance with a fixed antenna from 11 to 40 ft. long. Storage battery drain is 5 amp.



and occurs only while transmitting. Transmitter and power supply are in single housing and are remotely controlled.—AVIATION, July, '46.

Soldier Beware

(*Continued from page* 41)

The potential market for flight instruction is as great as the potential market for personal planes. Those already in the business on a solid basis are, in many areas, making a substantial living. In recent months, the aviation school business has been greatly enhanced by the expanded training provisions of the GI Bill (see article, "There's Real Business in That GI Flight Training Program," page 38, May AVIATION). If your school can meet the requirements, you can profit greatly from this large potential market for instruction.

The aforementioned CAA pamphlet, *Employment Outlook in Civil Aviation,* also contains a collection of factual information on how to start a flying school or an aircraft and engine repair shop. Additional advice can be obtained from the Aeronautical Training Society, 1025 Connecticut Ave., Washington.

Discharged servicemen and women who go into the business of civil aviation will profit and prosper in direct proportion to their knowledge of the obstacles and problems and their ability to meet those problems and surmount the obstacles. Both the present and future are excellent for those who have real ability, a sound background of training, sufficient capital, and a solidly founded knowledge of what they want to do and how to go about doing it.

But the veteran who lacks these qualities—the one who hopes to *fall* into a good civilian aviation job or a profitable aviation business, simply on the basis of his mere desire to get into civil aviation —will, nine times out of ten, fail.

Profits Balanced

(*Continued from page* 84)

aviation enterprise, with its present status largely depending on Army and Navy interest in its products. It has, however, a moderate but growing amount of commercial business and its full share of costly reconversion problems.

The 1946 earnings outlook is affected by a strike at the Ranger plant this spring, OPA ceiling prices for several products, material shortages in the Duramold and other divisions, lack of production facilities, and the need for larger production orders in several divisions. Consequently, the 1946 earnings outlook appears quite clouded at this writing.

Fairchild is developing a commercial version of the Packet. Commercial orders have not been accepted as yet, and it will be some time before the company is in position to quote prices and delivery dates for mail-carrying or commercial cargo versions of the Packet.

Beech Aircraft, despite heavy engineering and development expenses, reduced its reconversion operating deficit from $900,000 on Jan. 1 to $300,000 on Mar. 31. Deliveries are averaging $2,500,000 a month on the D-18 feederline and executive type plane. Beech has 500 orders for a four-passenger private plane which will go into production this summer. Also scheduled for 1946 production is a feederliner which will be in competition with similar proposed Lockheed and Boeing planes. Because of tooling and development costs that may run above $2,500,000 this year, profits on 1946 business probably will be nominal. Beech has set as its goal a sales volume of $50,000,000 next year compared with a prewar total of $2,345,000 in 1940 and a wartime peak of $97,044,000.

Curtiss-Wright Corp. is going through what one close observer of the company's activities likes to describe as a "soul-searching" period. Operations so far this year have been at a substantial deficit, and the immediate outlook is not promising as far as profits are concerned. It is still a moot question whether the company will stay in the commercial plane building field, though President Guy Vaughan stated emphatically it will continue in military work. "We shall continue to manufacture military airplanes and engines and propellers and various types of aircraft. What we are still considering is only whether we shall continue to manufacture *commercial* airplanes."

(*Continued at top of page* 143)

"With Gulf Super-Quench

we consistently get maximum hardening and no rejects for low hardness or distortion"

says this Metallurgist

The metallurgist is shown above consulting with a Gulf Service Engineer (right) on results with Gulf Super-Quench in quenching counter balance bearings.

"TO get correct case and core hardness and avoid distortion, the quench for our counter balance bearings has to be right," says this Metallurgist. "With Gulf Super-Quench we get just the results we want—maximum hardening on the case, and no rejects for low hardness or distortion."

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c) Relief valve
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May be used with power-driven pump, using hand-pump as an auxilliary.

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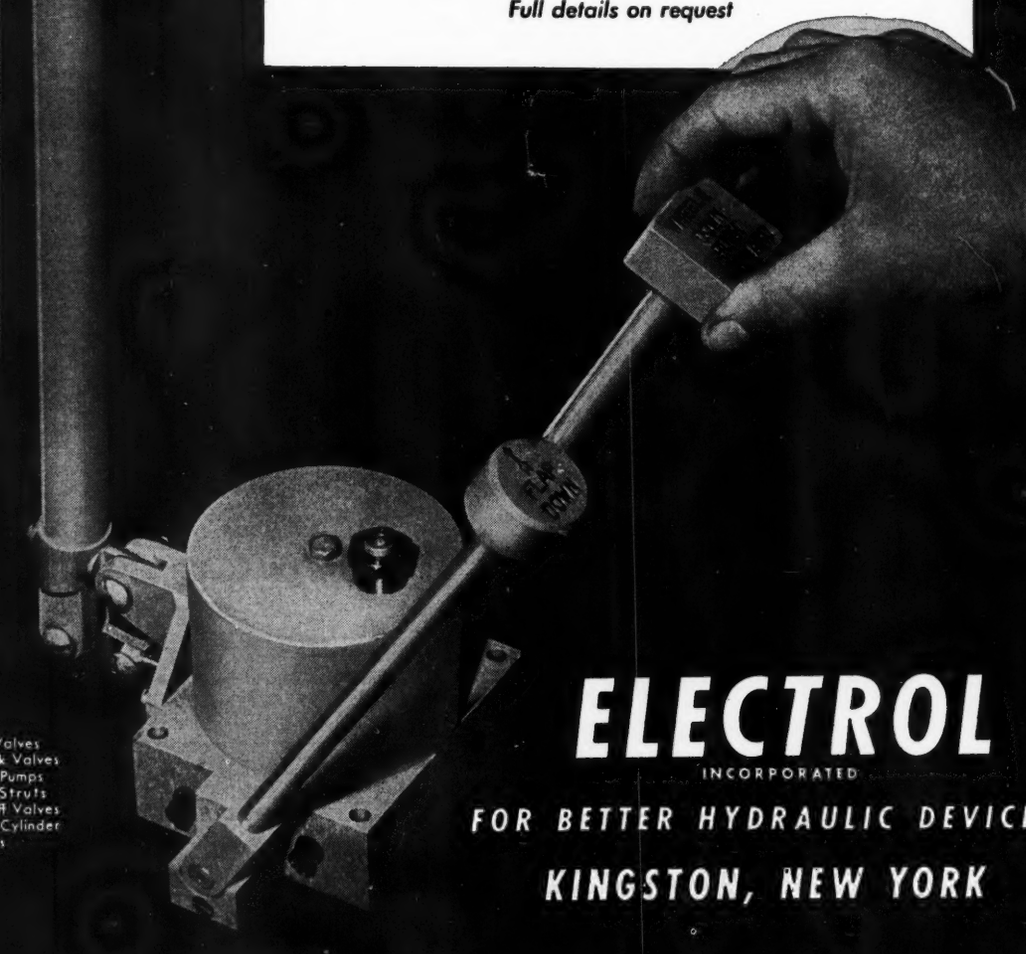

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Meanwhile, besides its Wright Aeronautical subsidiary and propeller business, Curtiss-Wright has purchased a couple of smaller companies in other lines and is amply supplied with cash resources to further diversify its operations if an opportunity arises to buy or merge with another concern. The Curtiss-Wright backlog totals approximately $85,000,000 contrasted with unfilled orders of $1,850,000,000 when the war ended. Dividends were omitted early this year and their resumption appears unlikely in the near future.

United Aircraft Corp. has enough business on hand to continue deliveries at the present rate of about $26,000,000 quarterly through the middle of 1947. Deliveries will run approximately half commercial and half military.

First quarter operations resulted in a $505,000 loss, and unsatisfactory earnings are indicated throughout most of 1946. Except for the carry-back provisions of the tax law, current losses would be much larger than they actually are. However, company officials believe United will be over the bulk of its reconversion by the end of this year. They hope that an improved relationship between costs and prices will prevail again in 1947 and permit a normal profit situation in that year.

Meanwhile the company's expenditures on development and research are unusually high. Of the present 20,000 employees, 20% are in engineering. Nearly all types of its engines and propellers have been re-engineered. About two years will be spent on intensive development of jet and gas turbine engines before United goes into production on these items.

In next month's article Mr. Hoadley will continue this survey with a swing to the West Coast, where another large group of leading aircraft firms also are grappling with reconversion problems.

New Radio Altimeters

(*Continued from page* 85)

(of duration T) has been completely transmitted but before the next pulse (occurring at time T) is transmitted. These restrictions limit the height that can be indicated, as shown in Fig. 1. The two indicating instruments used in these two types of altimeters are shown in Fig. 2.

Auxiliary Features

The basic altimeter can be modified in a variety of ways to perform special functions. The frequency modulation altimeter has an arrangement whereby the pilot can set on a panel dial the altitude at which he wishes to fly. A white light shows on an auxiliary indicator while the plane is within 10 ft. of this desired altitude; a red light shows if the plane falls below the limit, a green one if it rises above it. The same voltages that control these lights can be used to govern an automatic pilot.

It has been found advantageous to change the indicator scale when the altitude range is switched so as to avoid misinterpretation of the indication. On the pulse modulation altimeter, this scale change is accomplished by increasing the radius of the circle traced on the face of the cathode-ray tube indicator for the higher range.

Both altimeters depend for satisfactory operation on two short self-supporting antennas mounted on opposite sides of the fuselage so as to prevent direct radiation from the transmitting antenna to the receiving antenna. If mounted under metal covered wings, the wing surfaces provide sufficient reflection to direct a beam downward from these antenna reflectors. Early model altimeters were designed to operate from 27.5v. batteries, but if 400 cps. a.c. power were available on planes, the electronic equipment could be more compact and lighter.

Overhead Under the Thumb

(*Continued from page* 81)

that require replacement will be extra. Every mechanic knows the danger of trying to contract satisfactorily on an overhaul job in full—for there are sometimes many unpleasant surprises, once an engine is torn down.

With variations in labor or materials, a flat rate system would require revision. Flat rates are usually attractive to the customer, because they give him beforehand a close idea of what the job will cost him.

The methods employed by any modern auto repair shop can well be paralleled in airplane work, hence might be investigated to advantage by the operator, especially because the standardized job-and-service order forms can be adapted directly for use by the airplane and engine shop.

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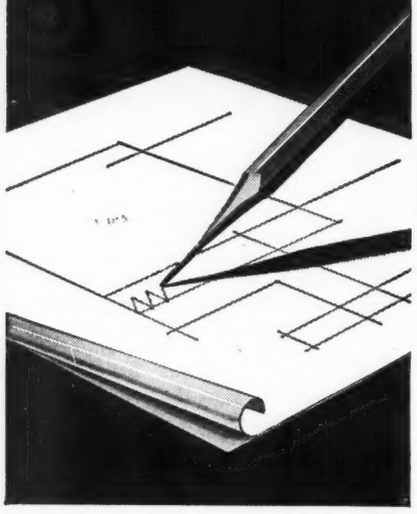

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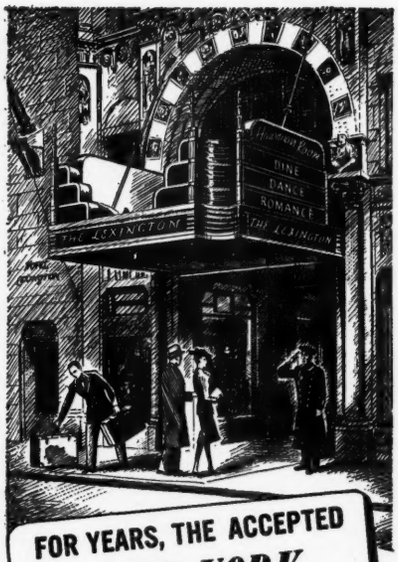

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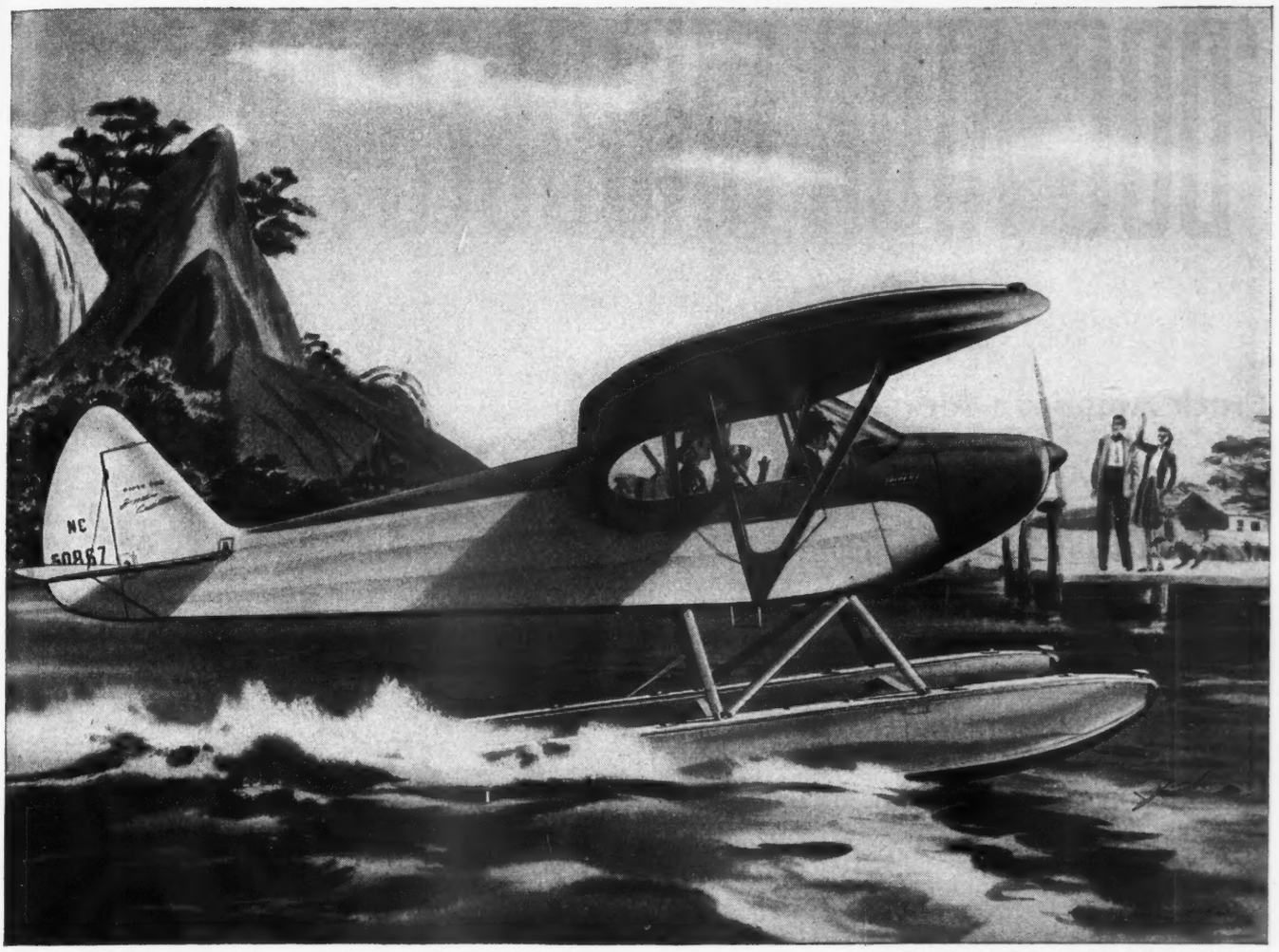

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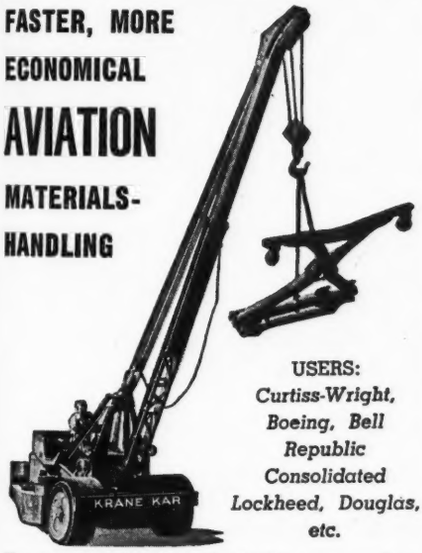

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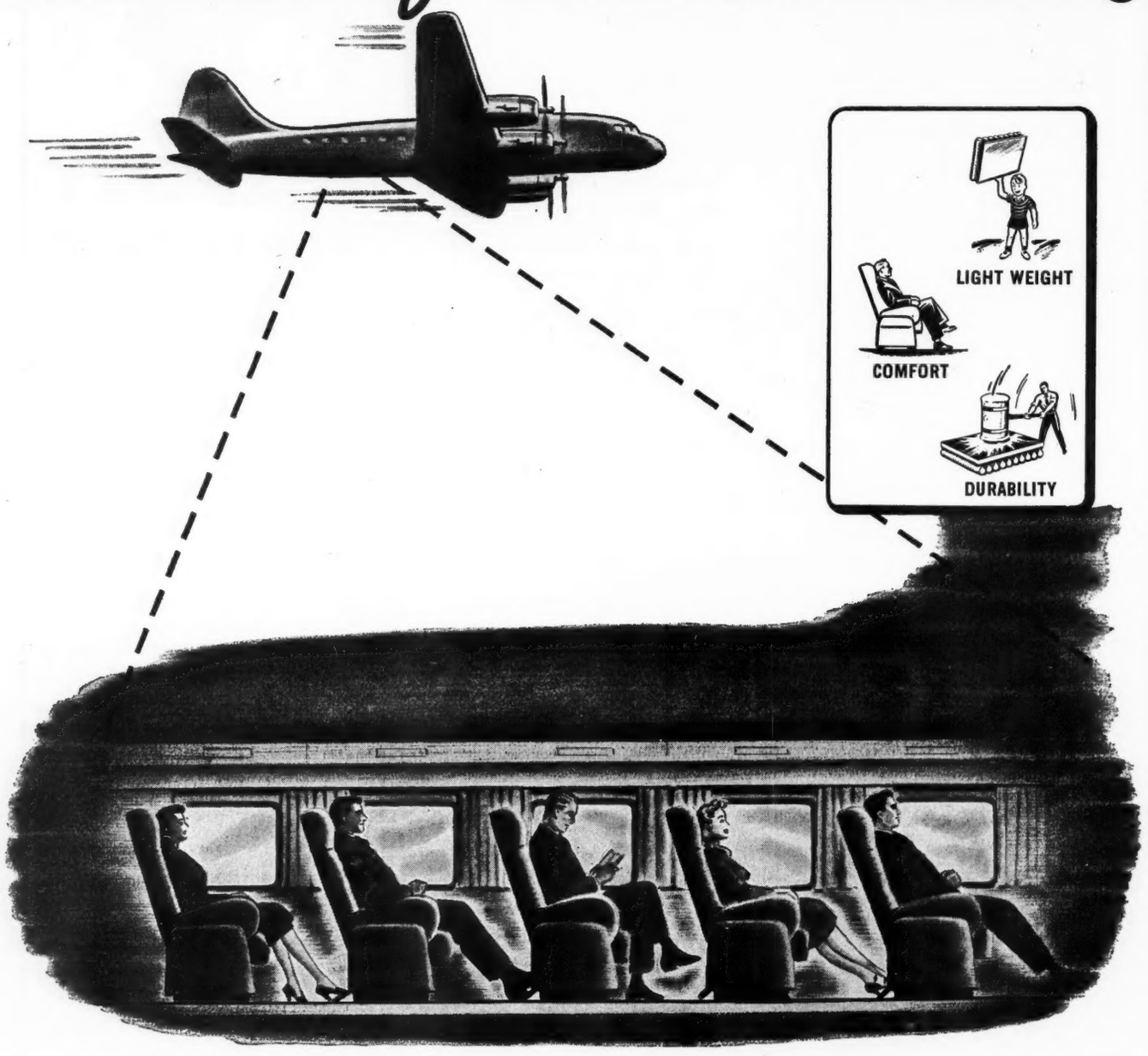

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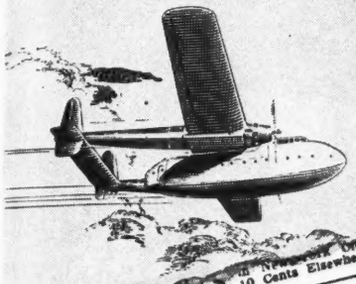

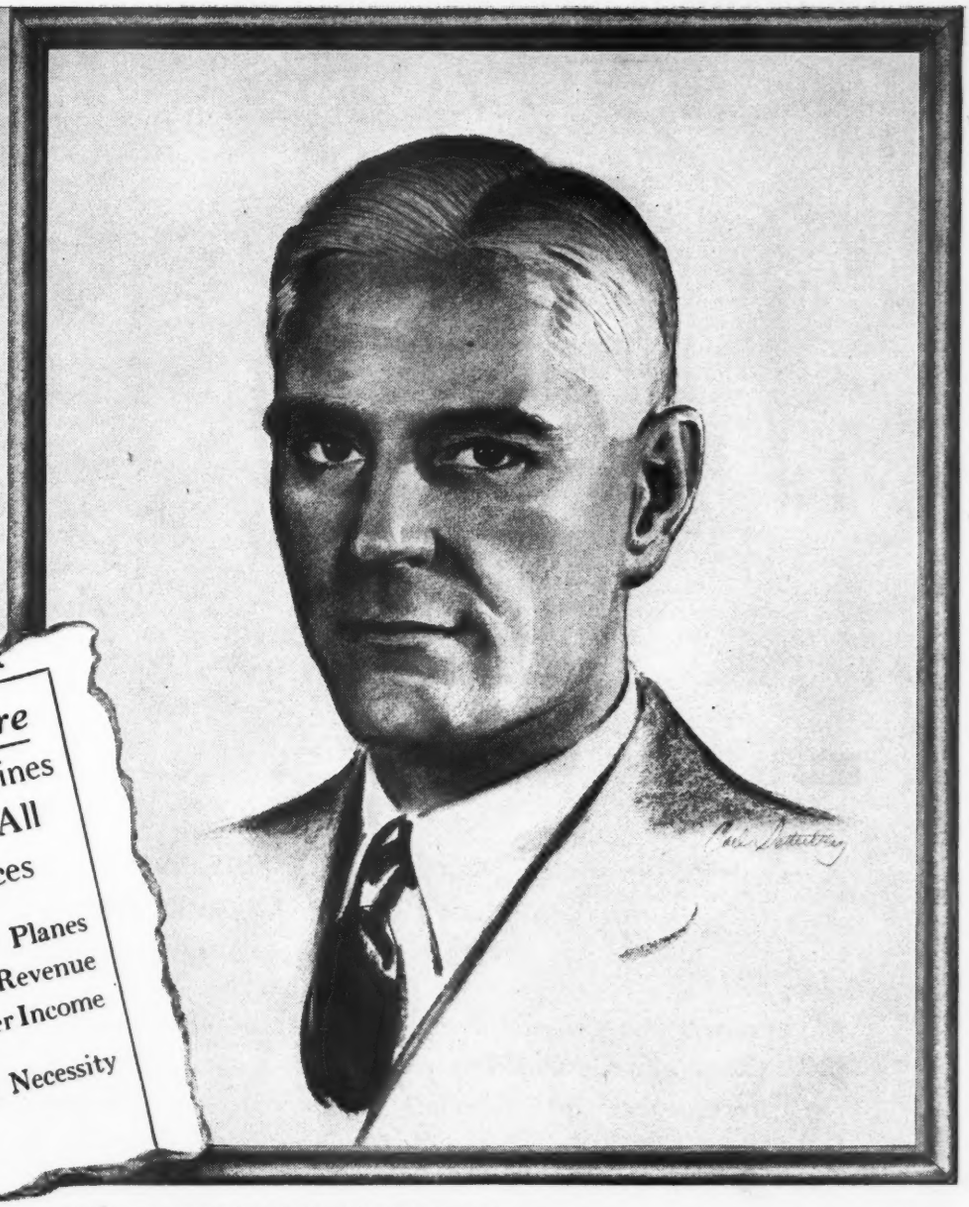

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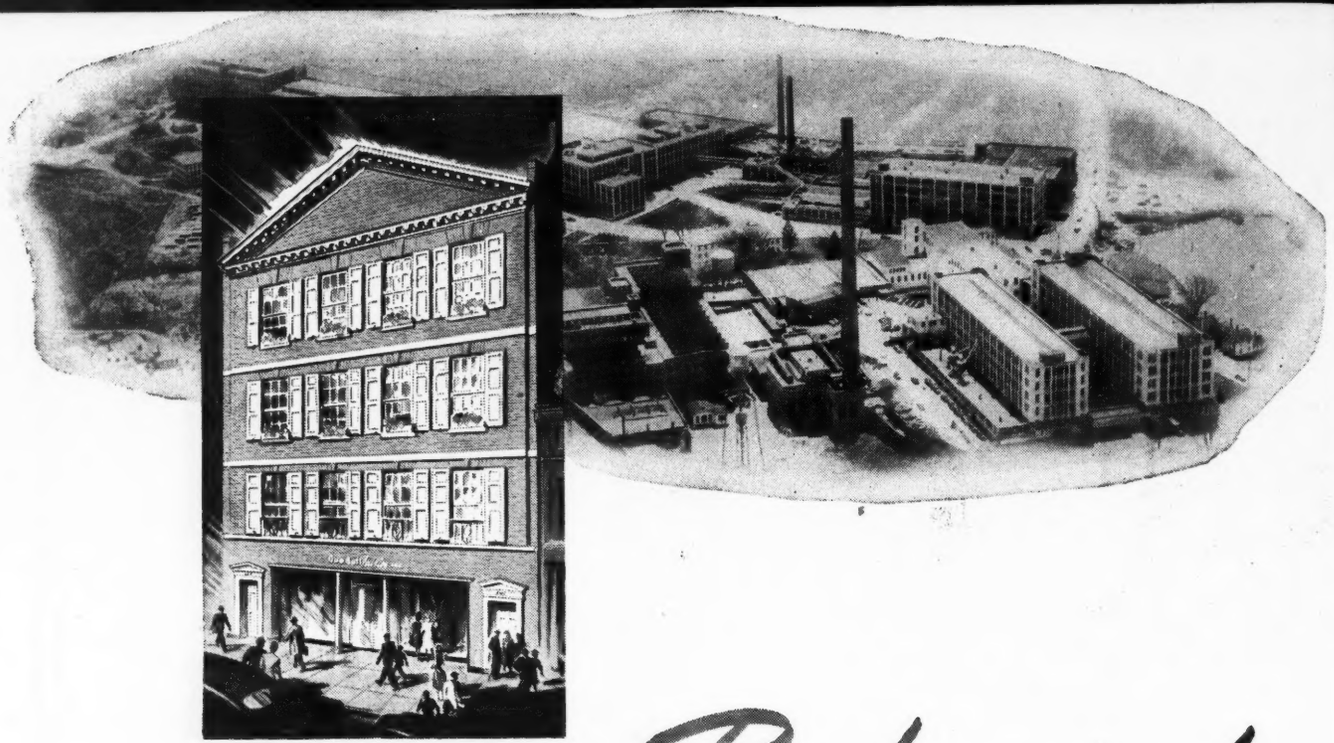

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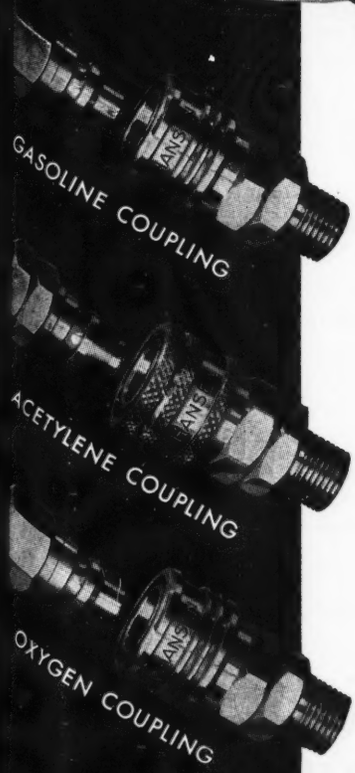

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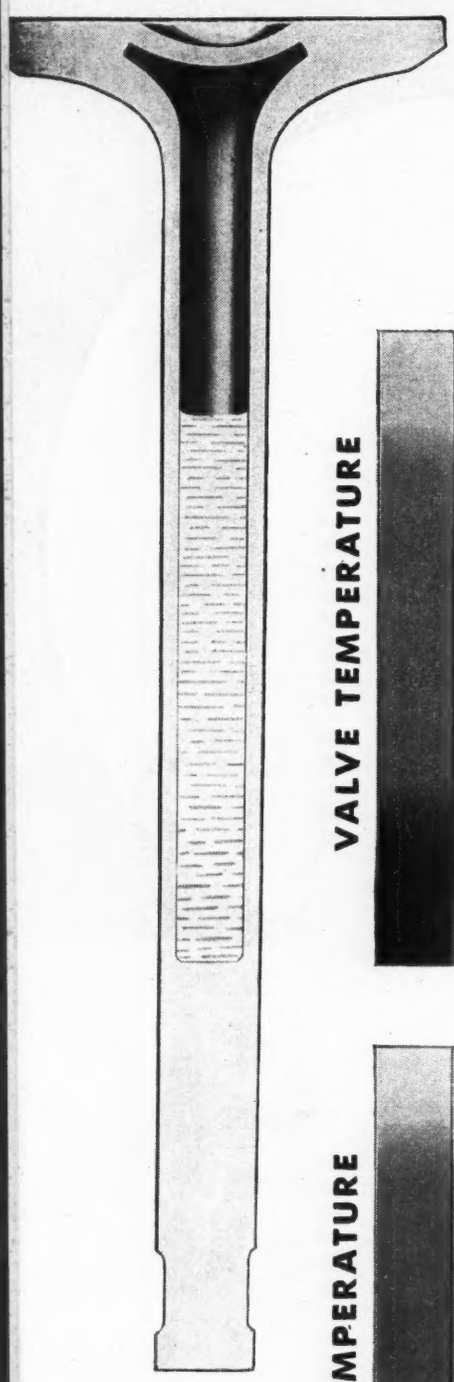

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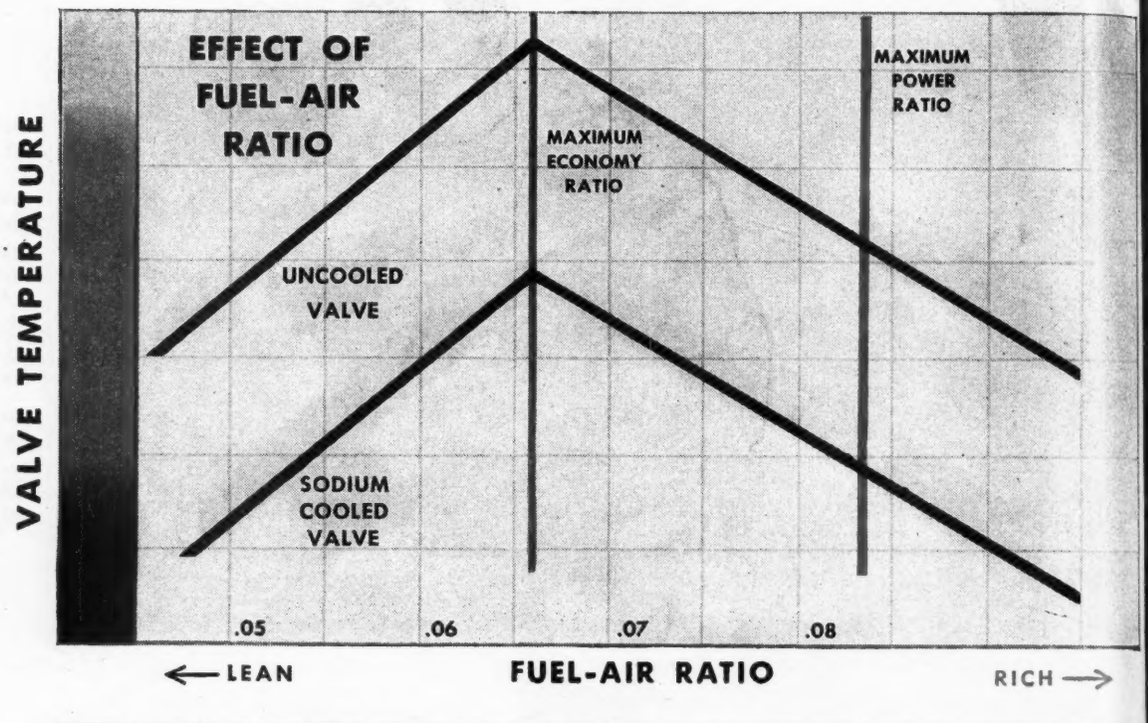

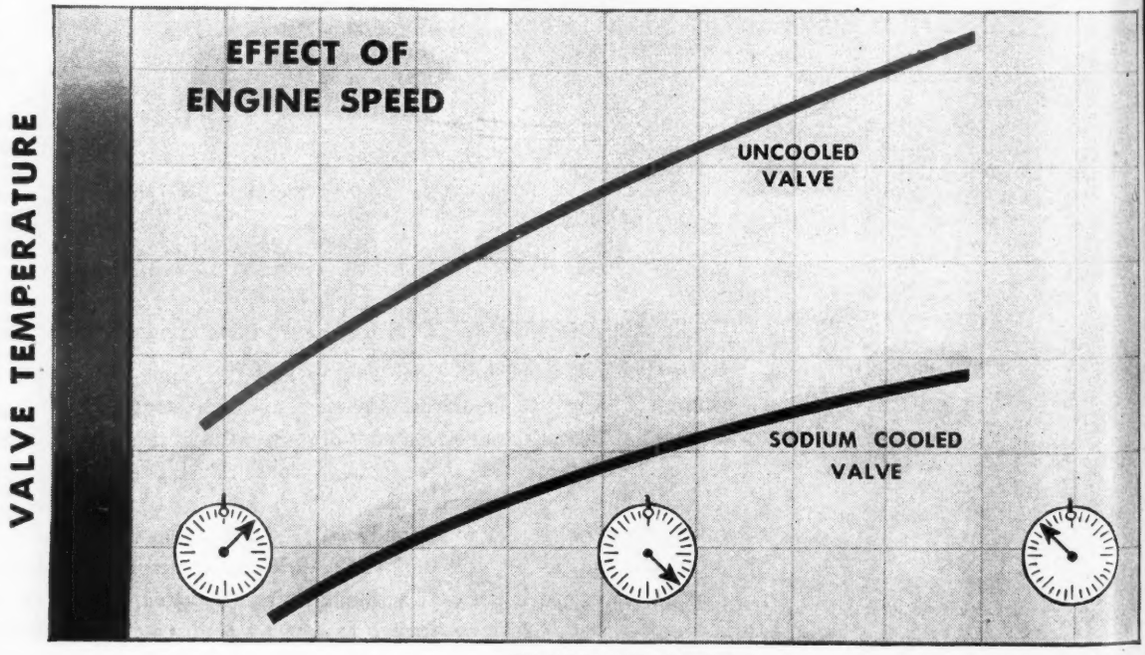

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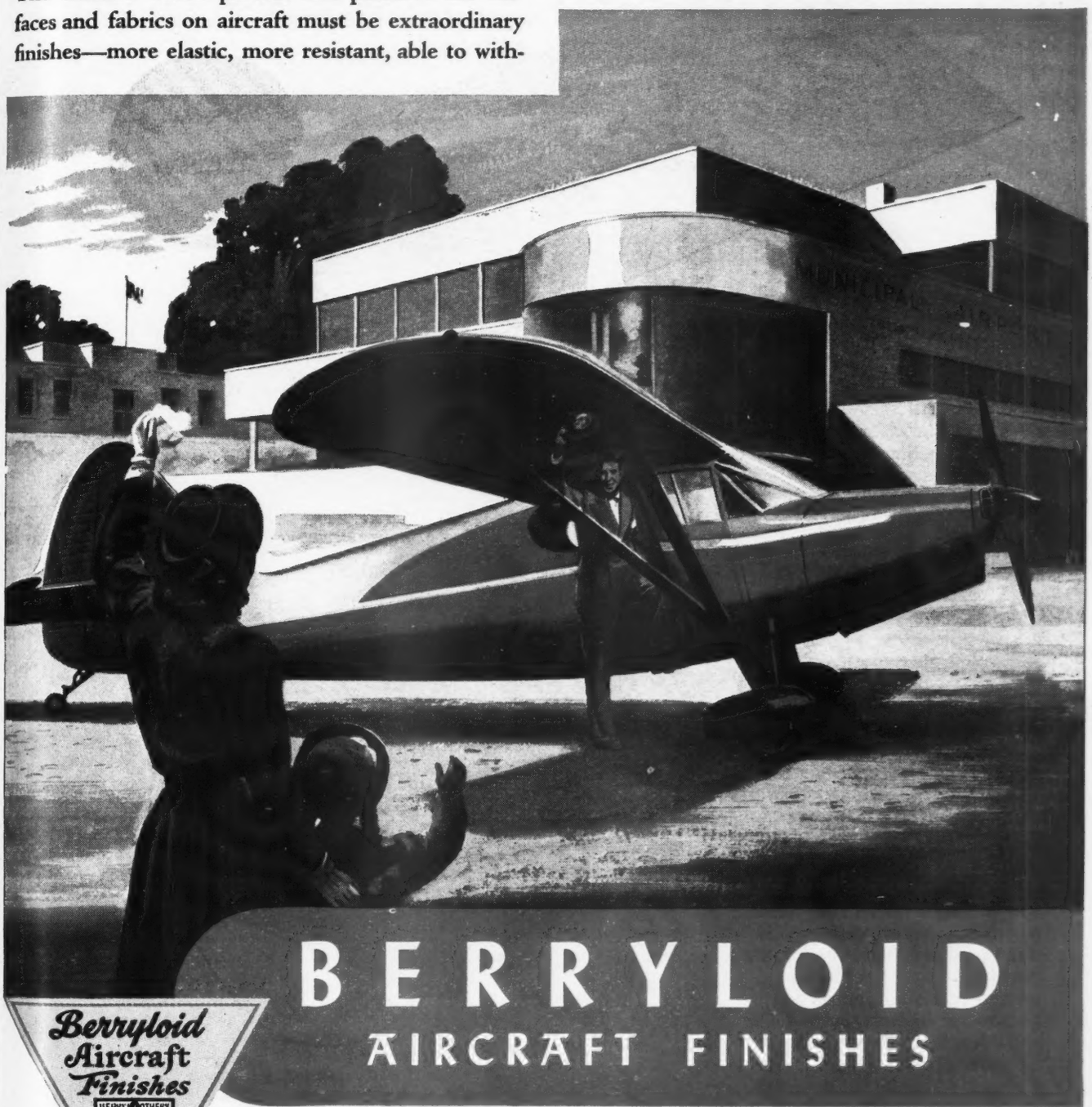

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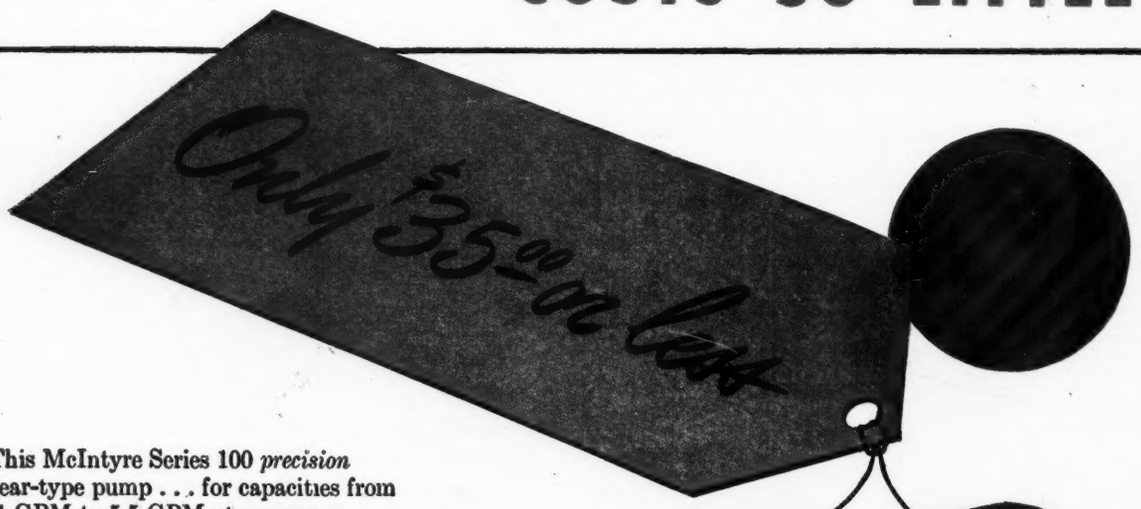

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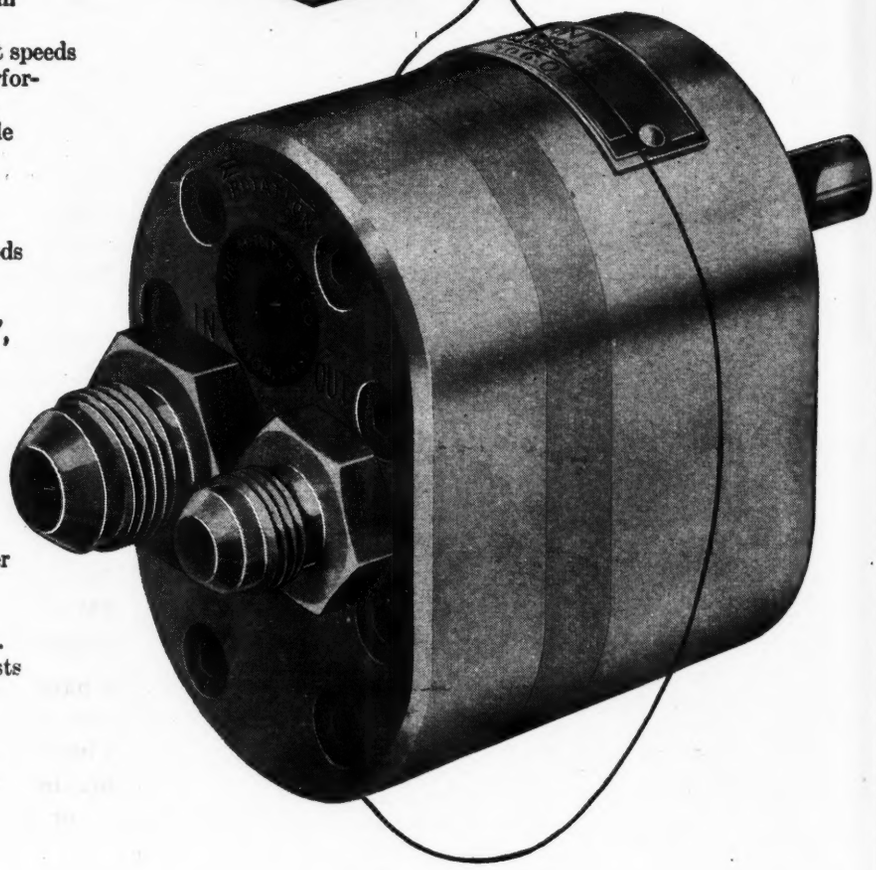

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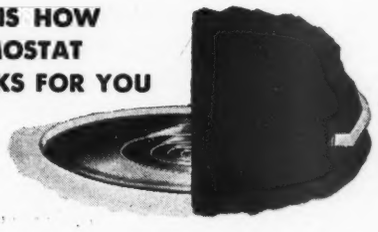
THE ULTIMATE IN PRECISION — *IDENTIFIED BY THE LIGHT BAND*

ANEMOSTAT DRAFTLESS AIR-DIFFUSION

. . . custom-built for passenger comfort

Wall-type ANEMOSTAT, located near the floor, is a specially designed unit for draftless heating. Other wall and ceiling-type ANEMOSTATS provide inlets for ventilation or conditioned air.

THIS IS HOW ANEMOSTAT WORKS FOR YOU



Due to its patented design, the ANEMOSTAT distributes air of any duct velocity in a multiplicity of planes in all directions. Simultaneously, the unit creates a series of counter-currents which siphon *into the* device cabin-air equal to about 35% of the supply-air. This cabin-air is mixed with the supply-air within the diffuser *before* the air-mixture is discharged into the cabin. The velocity of the discharged air is instantly reduced by air-expansion within the ANEMOSTAT.

In this way, the ANEMOSTAT diffuses air of any duct velocity *noiselessly and evenly, thoroughly and draftlessly* throughout the cabin . . . closely equalizes temperature and humidity . . . and prevents air-stratification.

Scientifically designed air-diffusers, based on thorough engineering research, will determine the correct air-diffusion patterns for *draftless air-comfort in aircraft . . .* with constant temperature equalization.

That is why close to one million ANEMOSTAT air-diffusers have already been installed in transportation and industry. For with ANEMOSTATS, conditioned air flows *smoothly, uniformly, in predetermined patterns . . . no drafts, no uneven temperatures, no stale-air pockets.* ANEMOSTATS are custom-built for passenger comfort.

It was ANEMOSTAT research and development, pioneered years ago, which resulted in the pre-war installation of ANEMOSTAT air-diffusers in the early airliners like the Pan-American "Philippine Clipper". And these same exacting engineering methods eliminated the even more intricate air-diffusion difficulties encountered in our war 'planes. Bombers, fighters and transports—in fact, 36 war plane models—were ANEMOSTAT-equipped during the war.

ANEMOSTATS HARMONIZE WITH ANY INTERIOR

While new cabin designs may require custom-built ANEMOSTATS to meet specific air-diffusion problems, all ANEMOSTATS blend with the interior motif of any passenger cabin.

If you have an air-diffusion problem in ventilating, heating or air-conditioning an ANEMOSTAT engineer can help you. Why not take advantage of his wide experience in air-flow research and control? Call us today . . . or *write now!*

AC-1048

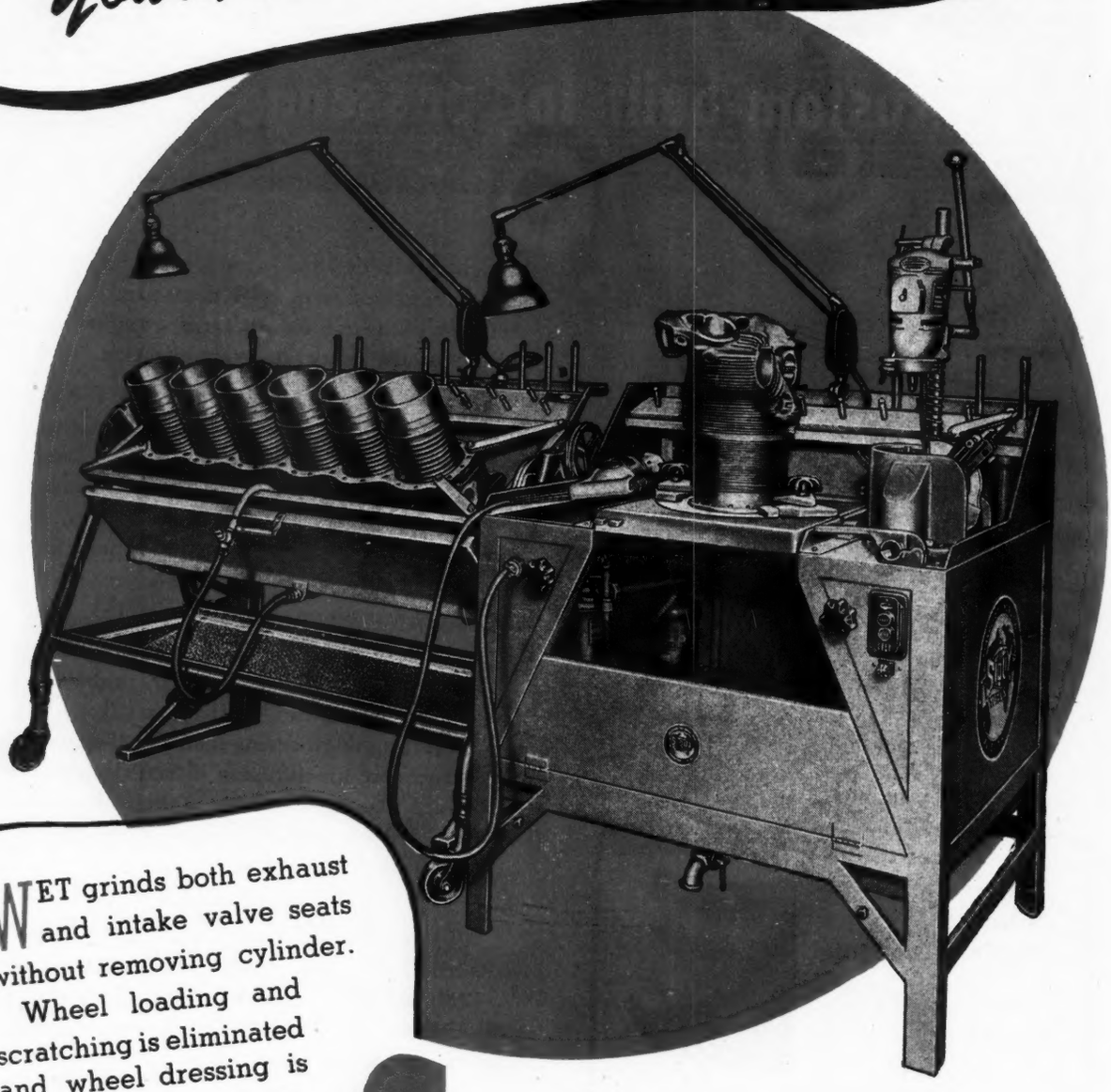
ANEMOSTAT

ANEMOSTAT CORPORATION OF AMERICA
10 East 39th Street, New York 16, N. Y.
REPRESENTATIVES IN PRINCIPAL CITIES

"NO VENTILATING OR AIR-CONDITIONING SYSTEM IS BETTER THAN ITS AIR-DISTRIBUTION"

In Production or Maintenance...

Your Assurance of Efficiency



WET grinds both exhaust and intake valve seats without removing cylinder.

Wheel loading and scratching is eliminated and wheel dressing is reduced to a minimum.

In both production and maintenance it enables operator to speed up with precision.

Write for Full Details

SIOUX AIRCRAFT

wet Valve Seat GRINDING MACHINE

for Inline and Radial Motors

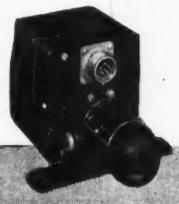
STANDARD THE WORLD OVER

ALBERTSON & CO., INC. SIOUX CITY, IOWA, U. S. A.

WHY HAVE MAJOR AIRLINES SWITCHED TO BENDIX PACIFIC FLASHERS?

LIGHTER...

MORE EFFICIENT...



EXTENDED SERVICE LIFE...

QUICK FACTS

- Operates on 6 watts.
- Available for 12 or 24 volts.
- Efficiency maintained at −65°F.
- Constant-speed, temperature-compensated ball bearing motor.
- Dimensions — 6-3/32 x 4-13/16 x 3-23/32.
- Total weight 1.82 lbs.

Bendix Pacific Position Light Flashers — *now in service on twenty-two major world airlines* — incorporate the new C.A.A. flashing sequence and provide radio interference filtering. The Flashers carry C.A.A. approval. Thousands of these Flashers have proved their reliability in military service and their extended troublefree service life has been further demonstrated by tests of well over 1000 hours of continuous operation with a six-ampere load on each of two light circuits. Write for complete specifications.

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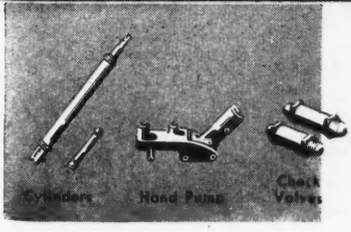
PRODUCT OF Bendix

HYDRAULIC & ELECTRICAL EQUIPMENT FOR AIRCRAFT

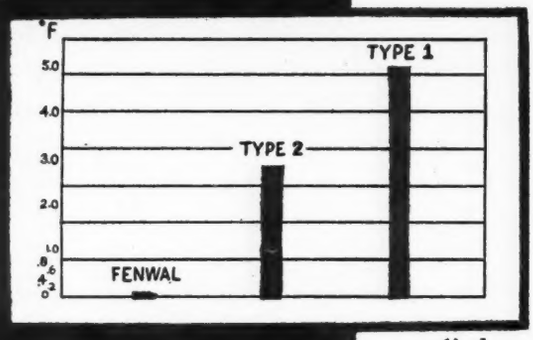
Pacific Division
Bendix Aviation Corporation
11607 SHERMAN WAY, N. HOLLYWOOD, CALIF.



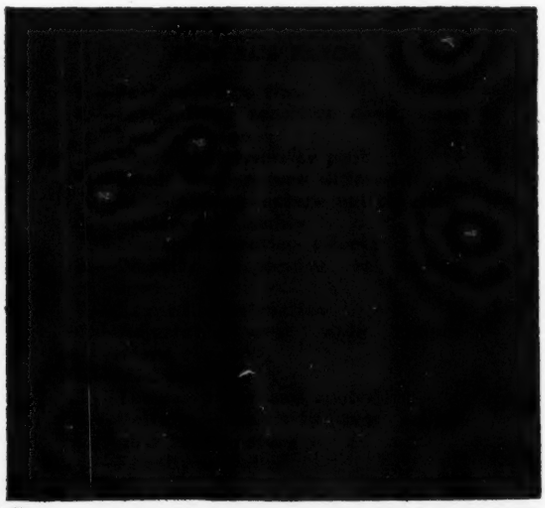
PERATURE AL*

You can't have close control of temperature if the controlling thermostat has a large operating temperature differential. Fenwal THERMOSWITCH Controls have an inherent minimal temperature differential which reduces temperature overshoot and undershoot effects. This small temperature differential can be increased to suit your requirements by proper THERMOSWITCH Control application.

Chart shows the small operating temperature differential of the Fenwal THERMOSWITCH Control compared to Type 1 and Type 2 thermostats. The force exerted by the expansion and contraction of the temperature sensitive brass shell is transmitted directly through the two anchored ends of the contact support members causing a positive make or break of the electrical contacts resulting in accurate temperature control.



Compact and easily installed, Fenwal THERMOSWITCH Controls have proven themselves in thousands of applications under all conditions. Investigate the advantages of THERMOSWITCH Controls as applied to your heat control problem. Send for your copy of the Thermotechnics Booklet which includes the "Fourteen Facts in Fenwal's Favor."



*#4 of the "Fourteen Facts in Fenwal's Favor".

FENWAL INCORPORATED

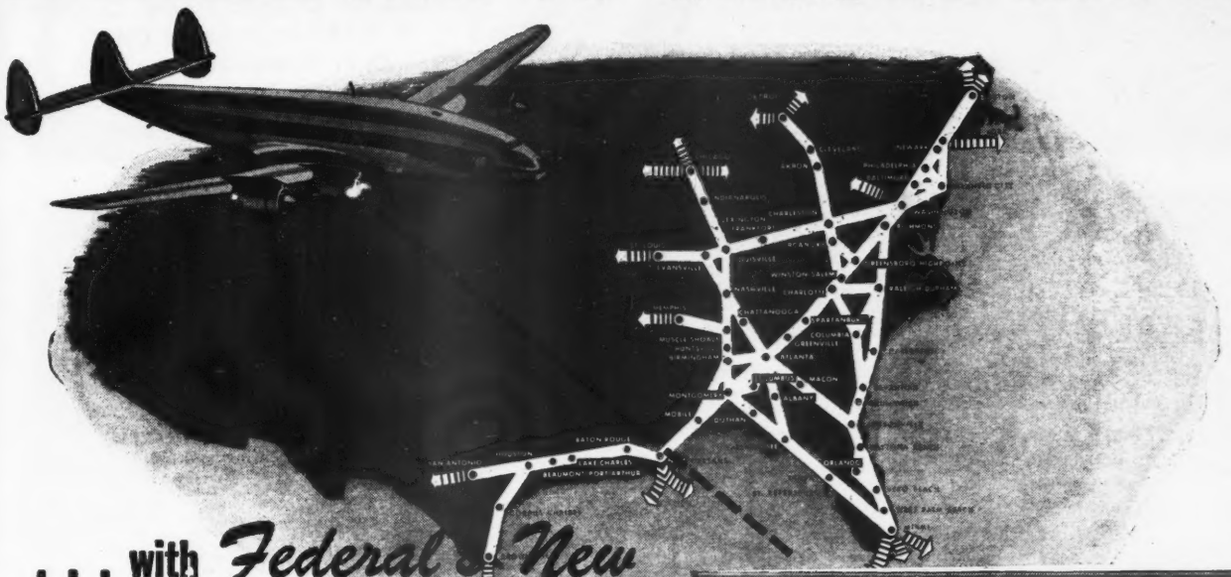
17 PLEASANT STREET

ASHLAND MASSACHUSETTS

Fenwal

THERMOTECHNICS FOR COMPLETE TEMPERATURE REGULATION

DEPENDABLE AIR-TO-GROUND RECEPTION

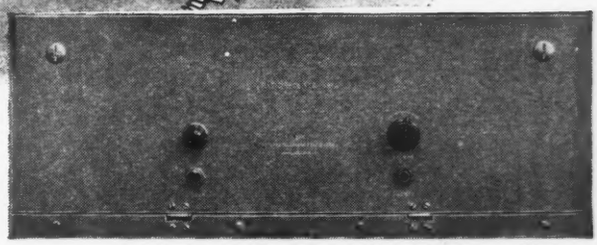


. . . with Federal's New VHF RADIO RECEIVER 139A

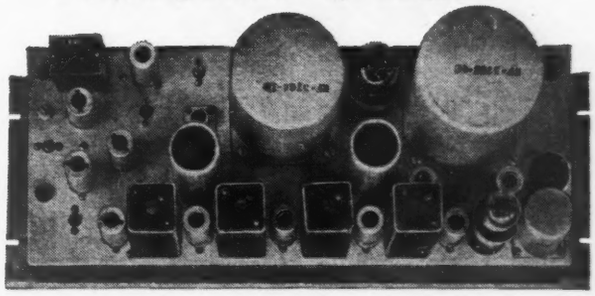
Ordered in Quantity by Eastern Airlines

FEDERAL'S NEW single channel ground station receiver 139A is especially designed for post-war commercial aviation service, in the band from 108 to 132 Mc; this range covers the recently assigned band for air-to-ground communication. This receiver offers many time- and trouble-saving features, with emphasis on reliability and simplicity of operation and maintenance.

This compact unit permits clear, dependable AM voice reception for airport control towers or remote unattended stations. Airlines and airport owners will find it a valuable means of safeguarding their vital communication systems. Eastern Airlines has already ordered a quantity of these units.



Front view, showing panel in operating position. Hinged at the bottom, this panel, when open, allows voltage measurements and inspection of all components to be made while set is operating, without removing it from the rack.



Rear view, showing transformers and tubes horizontally mounted on back, for free ventilation and ready accessibility.

Design Features of the FTR-139A

1. Designed for compact mounting in standard 19-inch relay rack
2. Front panel is hinged at bottom, giving unobstructed access to wiring for checking or maintenance
3. Designed for expected 100 KC channel separation
4. Crystal-controlled superhet circuit gives high performance
5. Either heated or unheated crystal holder can be used
6. Has carrier-operated noise-suppression circuit with adjustable threshold control
7. Includes provision for remote rf gain control
8. Amplified AVC

DATA

Power Output.....Max. undistorted, 750 MW
Max. output, 1000 MW
Frequency Range.....108 to 132 Megacycles
Power Input
70 Watts, 105-125 Volts, 50 to 60 Cycles
Dimensions....19" long by 7" high by 9" deep
Write today for complete information and performance data.

Federal Telephone and Radio Corporation

In Canada:—Federal Electric Manufacturing Company, Ltd., Montreal
Export Distributor:—International Standard Electric Corporation

Newark 1, New Jersey

An IT&T Associate

SELECTIVE CARBURIZED AND HARDENED TO EXACTING SPECIFICATIONS
AIRCRAFT QUALITY FINISH 13 MICRO-INCH FINISH ON O. D. 4 MICRO-INCH FINISH ON I. D.

Know-How IN PRODUCTION

It's a matter of record that, when certain of the country's largest manufacturers need hardened and precision ground parts that must adhere rigidly to quality specifications, they rely on Allied to produce them.

A typical part is shown above. It is made from AMS-6260 steel and selective carburized and hardened. On no surface can there be decarburization, nor is carburization permitted on the surfaces which remain soft. 60-63 C Rockwell is required for the hard portions. All tool marks must be removed, and the main outside diameter and the inside diameter call for specific and exceptionally fine surface finish.

Whether your parts may be difficult or simple, Allied can produce them for you . . . right . . . economically . . . and on time. Submit your part prints to us and we will offer our quotations without delay.

ALLIED PRODUCTS CORPORATION

DEPARTMENT 7-A
4614 LAWTON AVENUE
DETROIT 8, MICHIGAN

PRECISION • EXPERIENCE • DEPENDABILITY
ALLIED CORPORATION PRODUCTS

SPECIAL COLD FORGED PARTS • STANDARD CAP SCREWS • HARDENED AND PRECISION GROUND PARTS • SHEET METAL DIES FROM THE LARGEST TO THE SMALLEST • JIGS • FIXTURES • STEAM-HEATED PLASTIC MOLDS • SPECIAL PRODUCTION TOOLS • R-B INTERCHANGEABLE PUNCHES AND DIES • DIE MAKERS' SUPPLIES

This insulating block, made of canvas-base laminated, grade "C" Dilecto, is used in electrical switch boxes for signal equipment. To meet service requirements it must be structurally strong—and retain its electrical insulating properties under the extremes of temperature and moisture. It also must be easy to machine to meet volume production schedules and be dimensionally stable to facilitate installation.

For Real Engineering Help

On Non-Metallics

Look to Continental-Diamond First

If it's a question of building better insulation characteristics into your product to improve its overall performance, bring your problem to C-D technicians.

Here is a helpful, cooperative service that begins with a study of the job you want your product to do. It is that job which determines the exact C-D insulation material in one of the many types and grades or combination that best meets your particular insulation requirements.

A suggestion or two simplifying the design may be made also—possibly a method of fabrication providing a short cut to faster, more economical production and assembly of parts.

Take advantage of this seasoned C-D engineering help which avoids costly mistakes, wasted effort and product failure that go hand-in-hand with "second guessing." Phone, wire or write our nearest office and a C-D technician will be on his way to you.

SEE OUR CATALOG IN SWEET'S

C-D PRODUCTS

THE PLASTICS

DILECTO—Thermosetting Laminates.
CELORON—A Molded Phenolic.
DILECTENE—A Pure Resin Plastic Especially Suited to U-H-F Insulation.
HAVEG—Plastic Chemical Equipment, Pipe, Valves and Fittings.

THE NON-METALLICS

DIAMOND Vulcanized FIBRE.
VULCOID—Resin Impregnated Vulcanized Fibre.
MICABOND—Built-Up Mica Electrical Insulation.

STANDARD & SPECIAL FORMS

Available in Standard Sheets, Rods and Tubes; and Parts Fabricated, Formed or Molded to Specifications.

DESCRIPTIVE LITERATURE

Bulletin GF gives Comprehensive Data on all C-D Products. Individual Catalogs are also available.

Continental-Diamond C-D Engineered Non-Metallics

SDC-46

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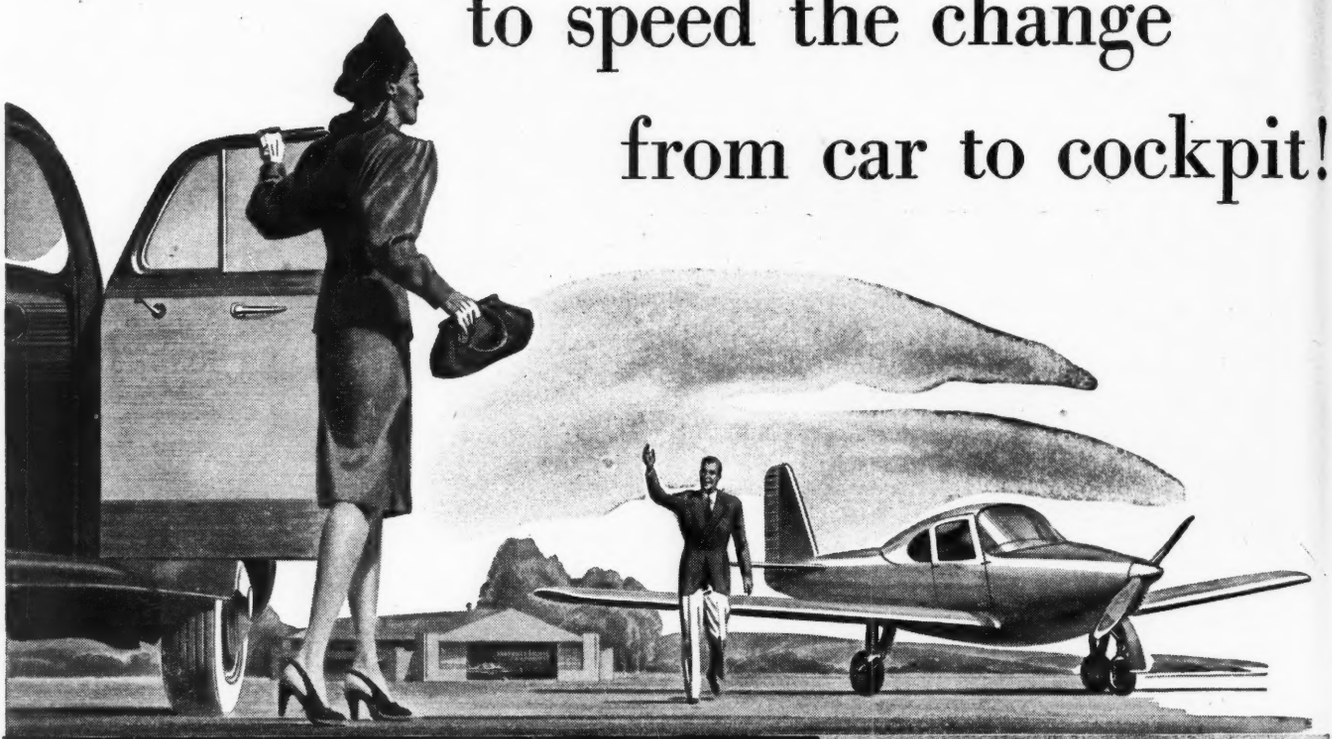
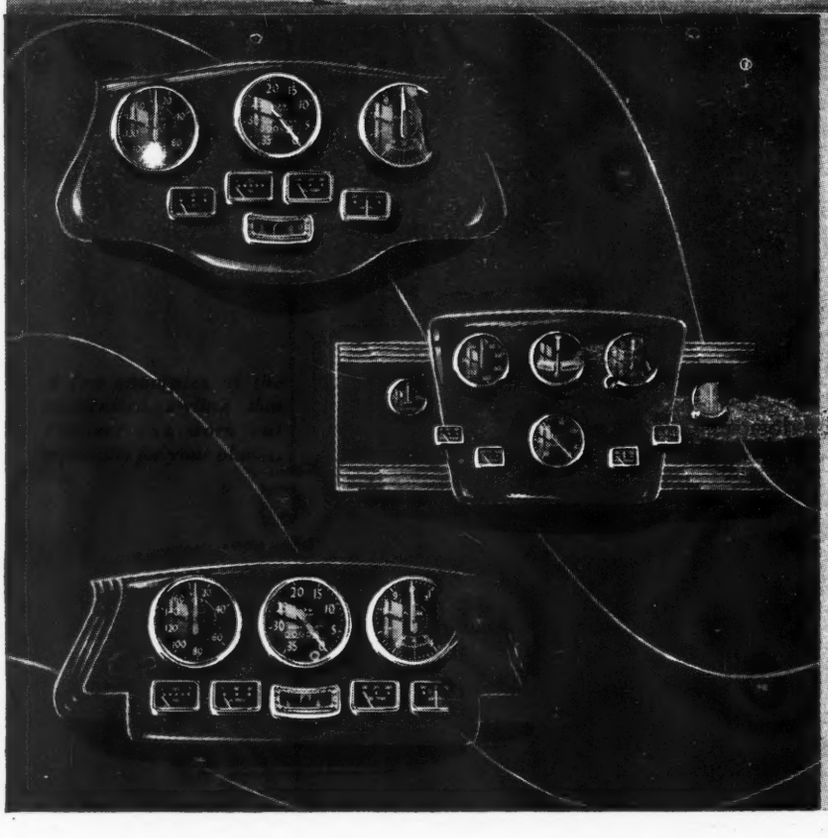
Continental-Diamond FIBRE COMPANY

Established 1895. . Manufacturers of Laminated Plastics since 1911 — NEWARK 3 • DELAWARE

A profitable way to speed the change from car to cockpit!





PIONEER

REG. U.S. PAT. OFF.

Flight Control

Instrument Panels for personal planes

PRODUCT OF Bendix AVIATION CORPORATION

Car buyers have learned to expect beauty and luxury in automobiles. They make up the largest part of your market, and will expect the same standards of beauty in the planes they buy. Pioneer —*working with you*—will design Flight Control Instrument Panels especially for your planes to provide them with the up-to-the-minute styling that is a *must* for this ready-made demand. Furnished to you in complete units, they make possible marked savings in assembly costs, and eliminate the stocking of individual instruments both in your plant and at your distributors. Maintenance is greatly simplified, and service costs thereby substantially lowered. Find out more about Pioneer Flight Control Instrument Panels—the *new* way to greater sales appeal for your planes, and lowered manufacturing costs for you.

ECLIPSE-PIONEER DIVISION
of Bendix Aviation Corporation
TETERBORO • NEW JERSEY

the more they'll need "*Equi-Tract*"

THE STEEL CONTROL CABLE THAT RETAINS CONTROL SENSITIVITY AT HIGH ALTITUDES

You can check another troublesome problem off your list of high altitude headaches. It's no longer necessary to install complex devices to compensate for the difference in expansion and contraction between airframe and control cable. U·S·S American *Equi-Tract* Control Cable reduces this differential 80% and maintains control sensitivity under extreme temperature variations.

How is this possible? The answer is in the steel wire itself, a product of extensive research. Instead of the old-fashioned system of installing heavy compensators, *Equi-Tract* brings you a control cable with a coefficient of expansion almost the same as that of the airframe. It permits simple and standardized maintenance practice.

Although *Equi-Tract* is new, it is already a proved product. Leading aircraft builders have put this improved control cable through its paces and have unanimously accepted it. Our engineers will gladly discuss the application of *Equi-Tract* to your designs.

LISTEN TO . . . the "Hour of Mystery" presented by United States Steel on the radio every Sunday evening. Consult your local newspaper for time and station.

AMERICAN STEEL & WIRE COMPANY

Cleveland, Chicago and New York

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Tennessee Coal, Iron & Railroad Company, Birmingham, *Southern Distributors*
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UNITED STATES STEEL

U·S·S American "EQUI-TRACT" *Control Cables*

AMERICAN STEEL & WIRE COMPANY · USS · AMERICAN *Equi-Tract* CONTROL CABLE · UNITED STATES STEEL

LOCK-CLAD—the aircord with an overcoat

Three serious control cord problems can be solved with a single type of control cable . . . Lock-Clad. Conceived by Lockheed, developed by Roebling, Lock-Clad is a 7 x 7 or 7 x 19 preformed and prestressed Aircord over which is swaged a duralumin tube on all sections not requiring flexibility. Here are the results:

Stretch

LOCK-CLAD has a higher AE value . . . reducing elastic stretch. Since the aircord is preformed and prestressed before being swaged, constructional stretch is held to an absolute minimum in the assembly and eliminated completely in the clad section.

Coefficient of Expansion

Lock-Clad's coefficient of expansion is high. It approaches that of the airframe itself . . . minimizing tightening and slackening caused by extreme temperature changes.

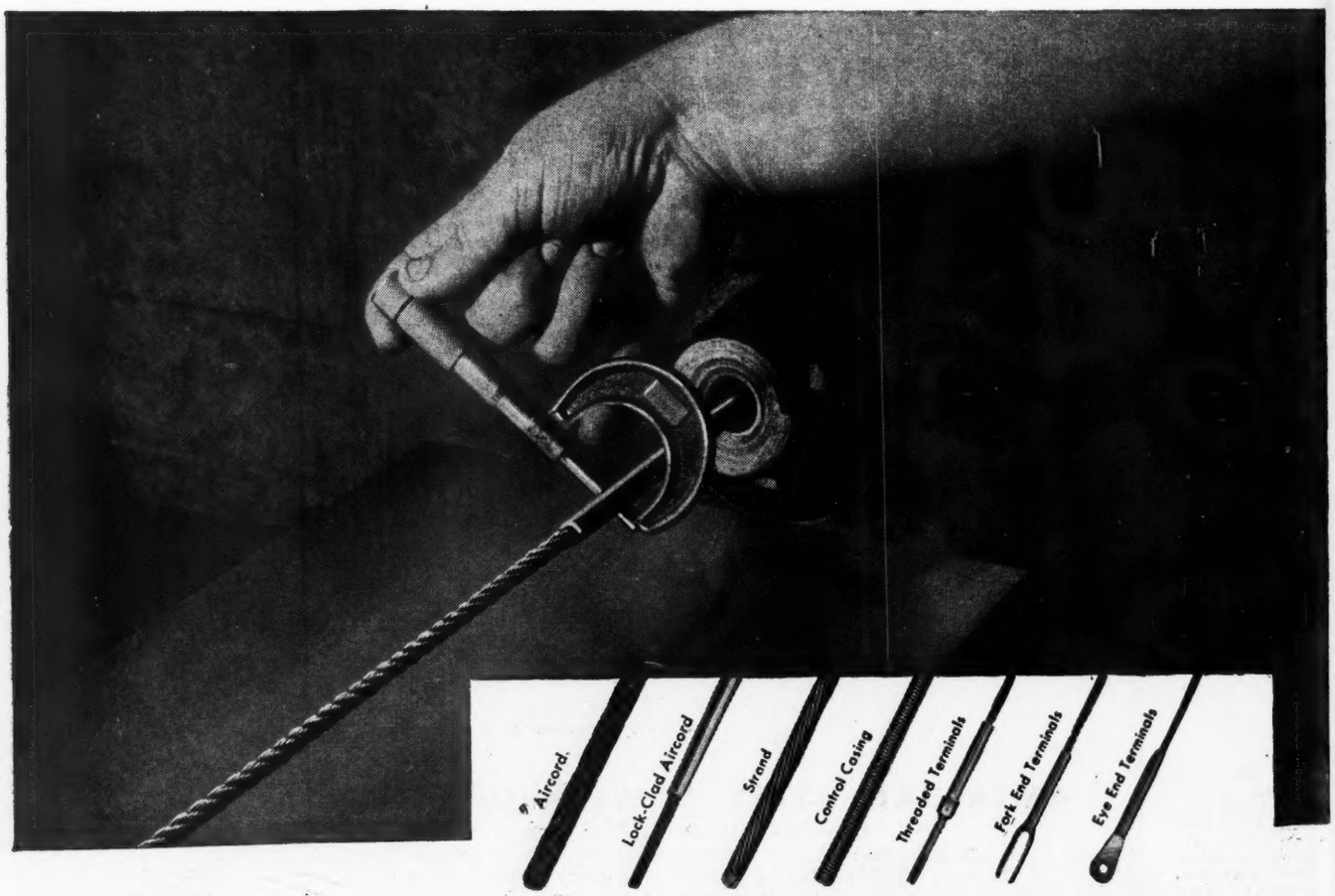
For Pressurized Cabins

The smooth cylindrical surface of Lock-Clad permits positive seal when it passes through the stuffing boxes of pressurized cabins.

Get All the Facts

Write for complete information and technical data on construction, sizes and physical characteristics.

Aircord Division
JOHN A. ROEBLING'S SONS COMPANY
TRENTON 2, NEW JERSEY
Branches and Warehouses in Principal Cities



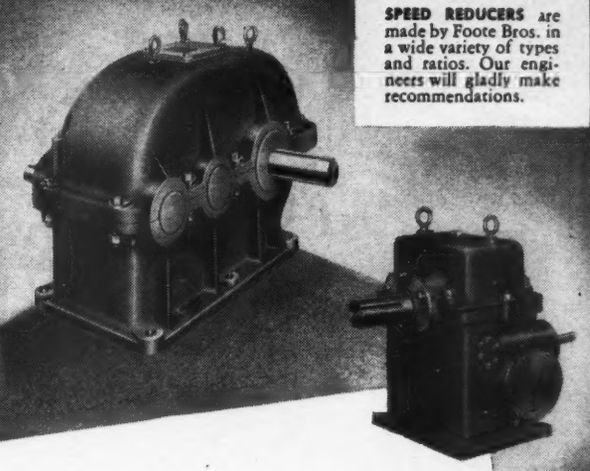
Other Roebling Aircraft Products include Wire Rope, Slings, Electrical Wires & Cables

ROEBLING

PACEMAKER IN WIRE PRODUCTS

"A-Q" (AIRCRAFT QUALITY) **GEARS** approach theoretical perfection. In airplane engines and other equipment, they assure extreme speed and efficiency and compact design.

SPEED REDUCERS are made by Foote Bros. in a wide variety of types and ratios. Our engineers will gladly make recommendations.



NEW WAYS TO SOLVE OLD PROBLEMS

You may have need for a gear 20 feet in diameter to drive a cement kiln. You may face a problem of transmitting power at extremely high speeds—an application that requires gears of laboratory precision. You may need a speed reducer for any one of a thousand applications or a Power Unit to fit a confined space.

Foote Bros. have been specialists in power transmission for nearly a century. During the war, Foote Bros. engineers have done the seemingly impossible both in the production of "A-Q" gears, and Power Units. If your designers are facing any problem in the application of power, let Foote Bros. engineers help them.

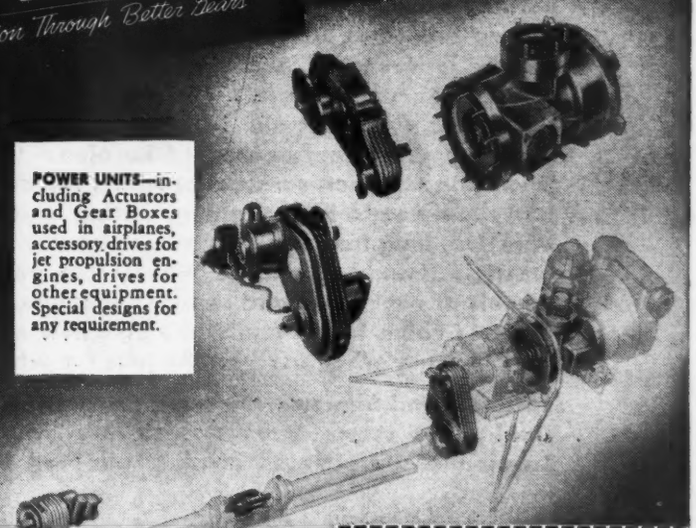
FOOTE BROS. GEAR AND MACHINE CORPORATION
5225 South Western Boulevard • Chicago 9, Illinois

Engineering bulletins on "A-Q" Gears and Power Units are sent on request. They offer many new suggestions.

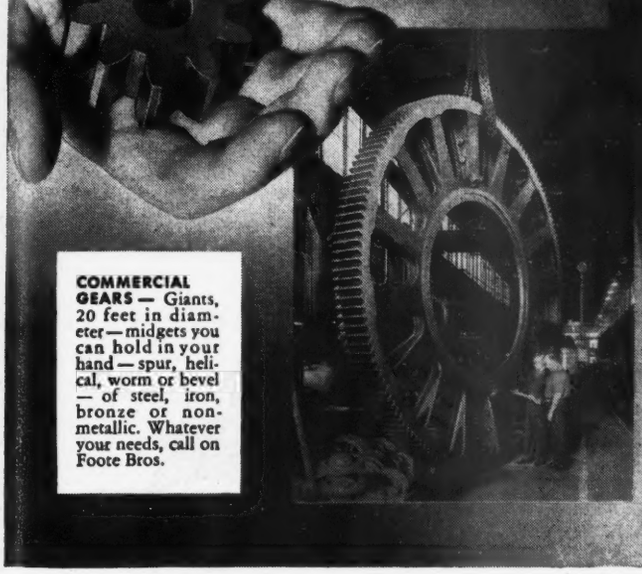
FOOTE BROS.

Better Power Transmission Through Better Gears

POWER UNITS—including Actuators and Gear Boxes used in airplanes, accessory drives for jet propulsion engines, drives for other equipment. Special designs for any requirement.

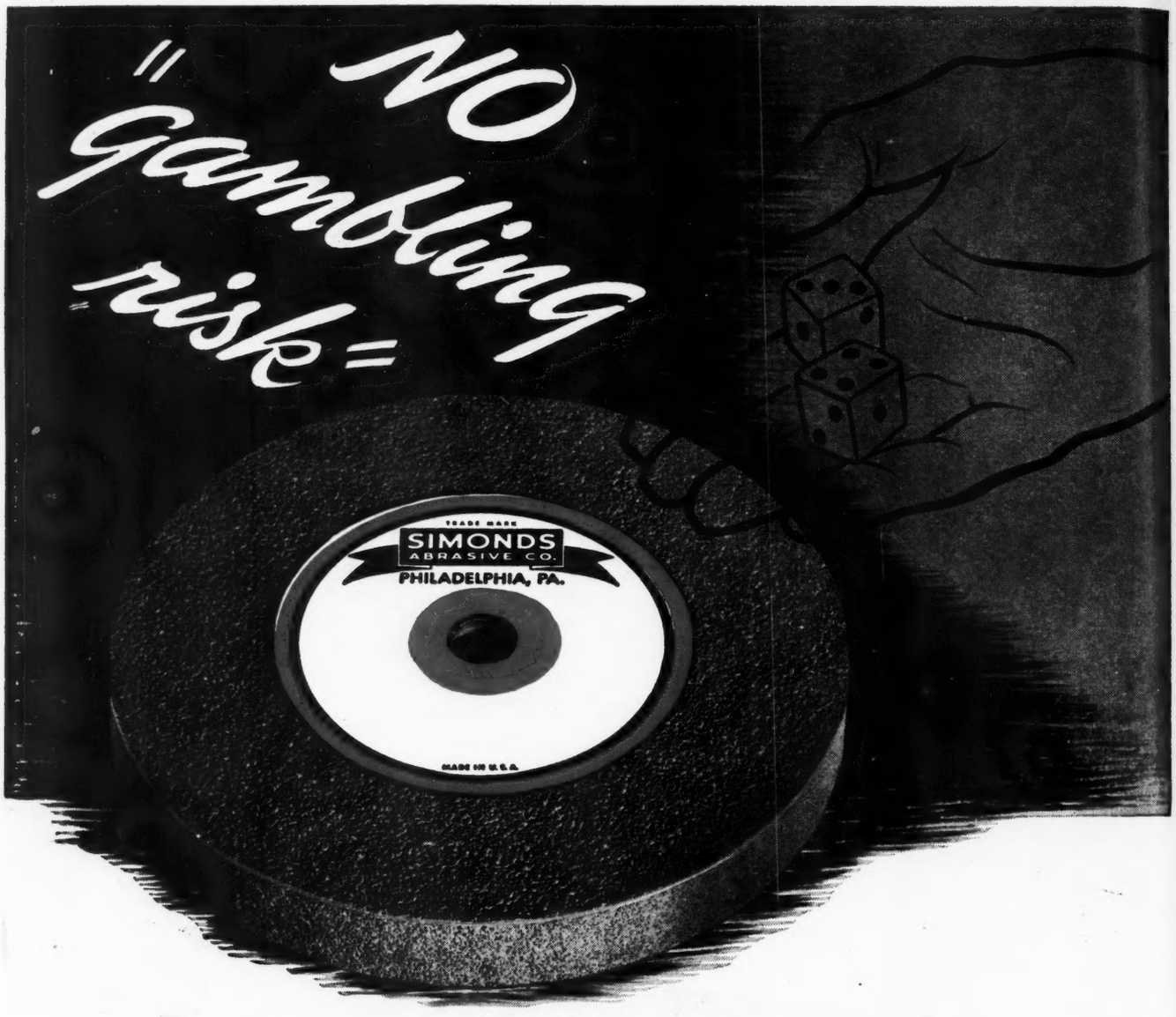


COMMERCIAL GEARS — Giants, 20 feet in diameter—midgets you can hold in your hand—spur, helical, worm or bevel — of steel, iron, bronze or nonmetallic. Whatever your needs, call on Foote Bros.



Foote Bros. Gear and Machine Corporation
Dept. G, 5225 S. Western Blvd., Chicago 9, Ill.
Gentlemen: Please send me Bulletins on:
☐ Power Units ☐ Aircraft Quality Gears

Name _____
Firm _____
Address _____
City _____ *State* _____



Efficient means of selection—control in manufacture that leaves nothing to chance—economical, lasting sureness of performance—these are some of the winning qualities that swing the odds solidly in favor of peak production efficiency when you use Simonds Abrasive Wheels. Thousands of combinations of various types and sizes of grain in every required structure and bond make up the complete line of Borolon* (aluminum oxide) and Electrolon* (silicon carbide) products for all your production and tool room needs. For roughing, cutting, snagging or finishing, for effective, long lasting performance on any material from steel to plastics, Simonds Abrasive Wheels are your best bet. Grinding wheels of every size and shape; Segments, Mounted Wheels and Points; Grains, Bricks and Sticks give new economy and long lasting efficiency when used on the jobs for which they are intended.

You will find Simonds Abrasive distributors, located in all principal cities, eager and ready to help you select the particular Borolon and Electrolon product adapted to every specific job.

***Time-honored Borolon and Electrolon Abrasive products are now distinguished by the name Simonds.**

SIMONDS ABRASIVE CO. is a Division of

SIMONDS SAW AND STEEL CO.

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SIMONDS ABRASIVE CO.

SIMONDS ABRASIVE COMPANY, PHILADELPHIA 37, PA. DISTRIBUTORS IN ALL PRINCIPAL CITIES

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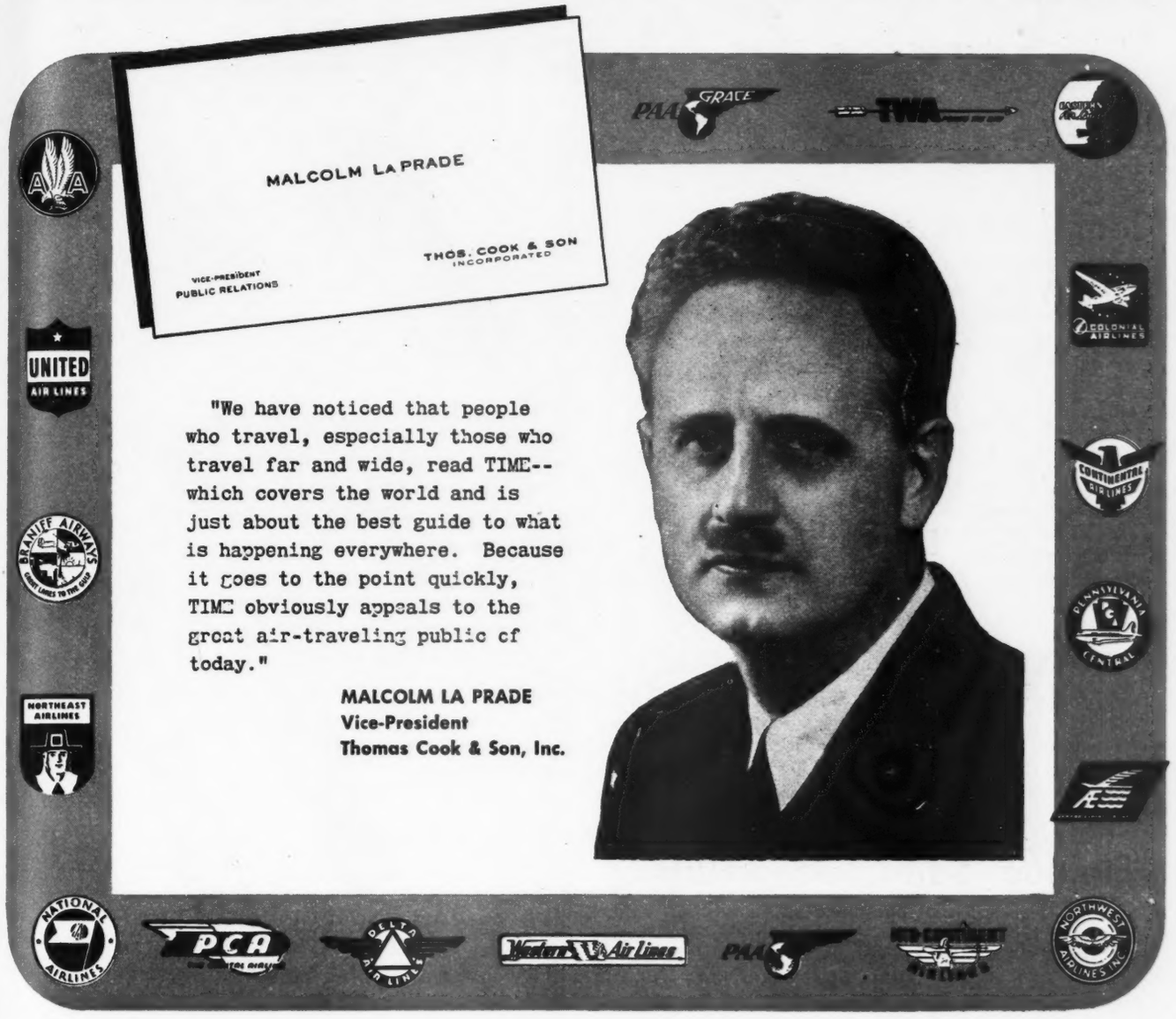
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"We have noticed that people who travel, especially those who travel far and wide, read TIME--which covers the world and is just about the best guide to what is happening everywhere. Because it goes to the point quickly, TIME obviously appeals to the great air-traveling public of today."
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ACROSS the U. S., agents who book plane travel agree with Mr. La Prade that their best and steadiest customers are the readers of TIME.*

The men and women who read TIME are the kind who habitually say "okay" to any better, quicker way of doing things. They have already flown more than three billion airline miles. And they have the business interests, vacation time, and high incomes to go right on being the nation's best market for the best that airlines and travel bureaus can offer.

*Aviation executives know it too. Writes the assistant to the president of a leading airline, "TIME is about the most popular publication carried aboard our ships."

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For "ALL AROUND"
Service in Shop and Plane

Compactness:

TIME-SAVER: The knurled "Unbrako" Socket Head Cap Screw ("A") is an Internal Wrenching Screw and therefore facilitates compact and weight saving construction. Its knurled head provides a slip-proof grip even for oily fingers which speeds up assembly.

Won't Shake Loose:

The "Unbrako" Socket Set Screw with the Knurled Point ("B") is a *Self-Locker*, because the knurled point digs-in and holds firm—against even the most stubborn vibration. Yet, this screw can easily be backed-out with a wrench and used again and again. Both "A" and "B" are available in sizes from #4 to 1½"; write for the "Unbrako" Catalog.

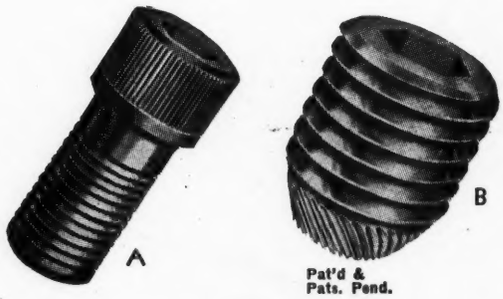
For Accuracy, Dependability:

The "Unbrako" Internal Wrenching Bolt ("C") and 100° Flush-Head Socket Bolt ("D") meet the extreme degree of precision, tensile, fatigue and inspection demanded by the aircraft industry . . . possible only through our trained craftsmen as well as our modern precision and metallurgical equipment.

"Flexloc" Self-Locking Nut:

The "D" "Flexloc" is of one-piece all metal construction and every thread, including the locking threads, carries its share of the load. Thin nuts made thus, are especially superior. Its milled flexible top locks on a wide range of tolerances. Practically unaffected by heat to 650° F. It can be used over and over again without losing its ability to lock. Sizes from #6 to 1" in diameter; coarse and fine threads; millions in use. Write for Bulletin #582.

"Unbrako" and "Hallowell" products are sold entirely through distributors.



UNBRAKO

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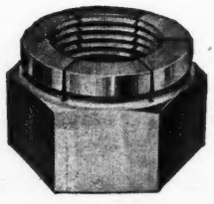

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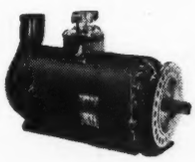
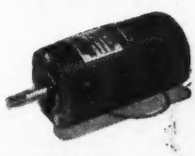
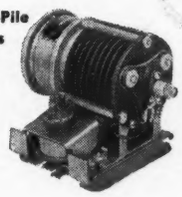


Differential Voltage Relay Switches

Motors



Stabilized Carbon-Pile Voltage Regulators



More watts are needed for galley operations alone, in addition to all the other comfortization that transforms the "freight car" interior of a C-47 into a DC-3.

More power is easily built into a DC-3 on conversion by replacing existing generators with modern wide-speed-range units of greater capacity. This added power is needed for the heating, cooling, ventilating, individual lighting and added communications equipment—for all the added comfort and safety factors that attract and hold customers.

Conversions like this are now being made using Westinghouse equipment throughout, and utilizing the experience of Westinghouse engineers. These men are thoroughly familiar with the details of the apparatus needed and of the engineering involved. Always look to Westinghouse—your electrical partner in aviation progress—for aid in this and other aeronautical advancements. Ask your Westinghouse representative for details, or write to Westinghouse Electric Corporation, Lima, Ohio.

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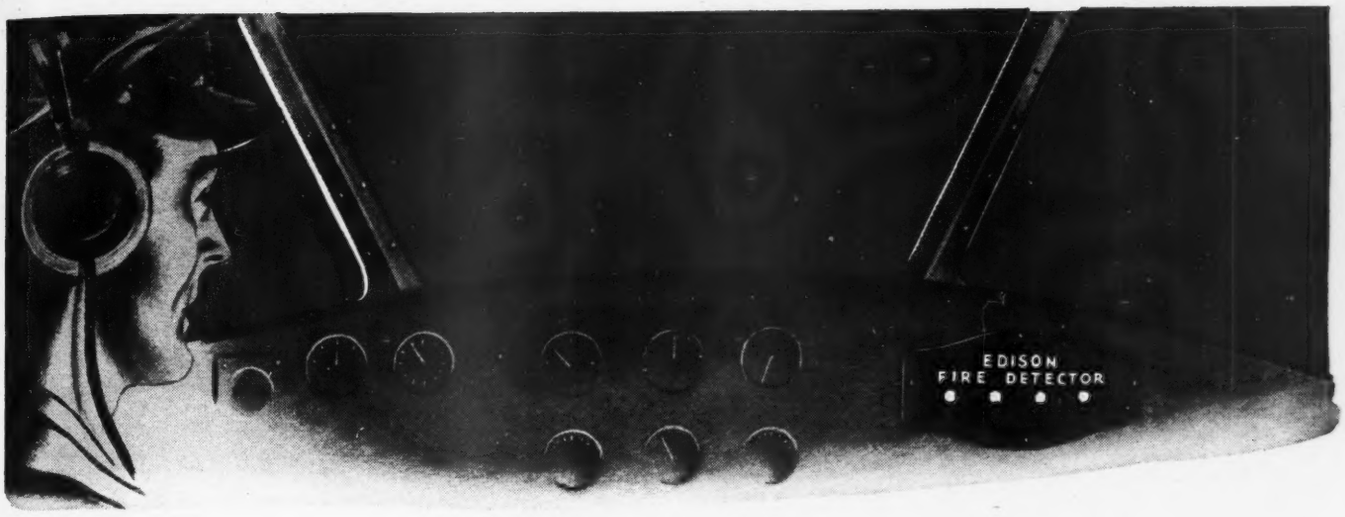

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Fire can never surprise a plane equipped with an EDISON Aircraft Fire Detection System.

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EDISON

Thomas A. Edison, Incorporated
Instrument Division, Department B
West Orange, New Jersey

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Aeromatic Propellers are easier to sell than most high quality equipment . . . because their advantages are so basic, so simple to demonstrate to a prospect.

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Aeromatic Propellers have that ideal combination of yielding a profitable return on the initial sale . . . and helping bring *more business* your way thereafter. And there's the further advantage of selling an exclusive item, too . . . since Aeromatic is the *only* fully automatic variable pitch propeller!

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have much in common:

Felt Roller Bearing Wick, showing an ingenious method of reservoir filling. Metal feed tube insert permits rapid oil replacement. While the oil is moving to the friction point, it is being filtered . . . freed from impurities.

Yes indeed, the smart Felt "creation" from the milliner's on the Avenue . . . and the humble Felt wick or pad that solves difficult machine lubrication problems are both *felted* from lamb's wool.

Nothing but Felt will hold oil ready to bleed immediately at dangerous friction points. This "watch dog" alertness of Felt results from its capillarity — makes it the preferred agent for lubricating large and small armature shafts, journal bearings, spindles and remote machine parts. Felt pads absorb, store and distribute oil, water, ink and other process fluids in automatic printing equipment, numbering and postage machines.

There are many other uses of Felt in industry — as shock, vibration and sound-absorber, thermal insulator, polisher, spacer. To obtain the benefits of technological advances in Felt, consult an American Felt Company sales engineer or write on your letterhead for appropriate Data Sheets and samples of Felt.

AMERICAN FELT COMPANY DATA SHEETS

Write for those you need to complete your Felt reference file.

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- No. 2—Adhesives for Felt Application
- No. 3—"K" Felt—Sound Absorption and Thermal Insulation
- No. 4—Special Felt Treatments
- No. 5—S.A.E. Specifications and U. S. Navy 27F7
- No. 6—Felt and Lubrication
- No. 7—A.S.T.M. Methods of Test for Wool Felt, D461
- No. 8—U. S. Army Specification No. 8-15G
- No. 9—Sheet Felts, standard Grades and Specifications
- No. 10—Vibration Isolation With Felt
- No. 11—Felt Seals, Their Design and Application
- No. 12—Flame-proofed Felt
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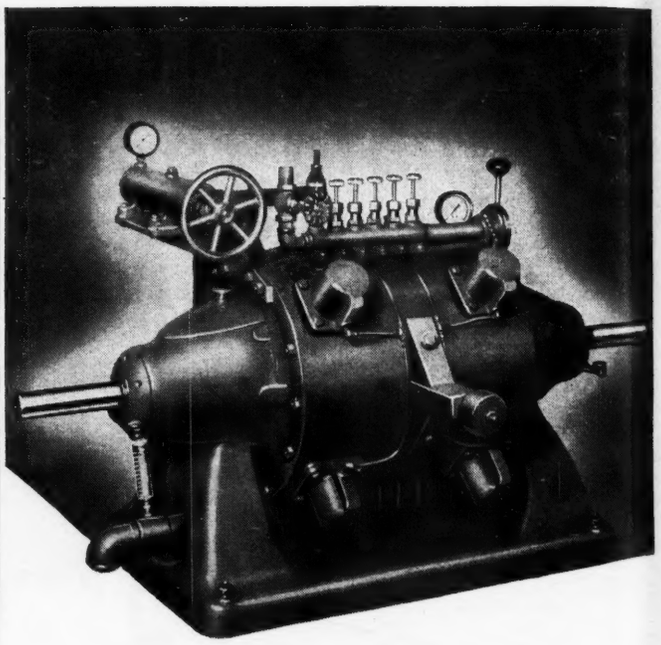

"LO-SPEED, HI-TORQUE"

HI-EFF DYNAMOMETER WITH PRONY BRAKE

High-torque testing at speeds right down to zero R.P.M.! That is what you can do with the combination of hydraulic dynamometer and Prony brake—an exclusive HI-EFF feature. In addition to the standard hydraulic rotors for high- and medium-speed testing, low-speed brake drums are an integral part of the dynamometer . . . both cooled by the same circulating water. This unique arrangement results in an exceptionally wide range of speed and B.H.P. capacity in one machine—greatly broadens the possible testing range. The hydraulic rotors may be operated alone, the Prony brake operated alone, or both rotors and brake operated in combination.

If you are faced with a low-speed, high-torque testing problem, or if you are in need of a dynamometer with the widest range of testing capacities, let us give you details of HI-EFF applications. Taylor Manufacturing Co., 3074 W. Meinecke Ave., Milwaukee 10, Wisconsin.

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A GOOD "POINTER" FOR ANY PILOT!

■ That's the *pointer* on the Sperry Automatic Radio Direction Finder . . . the pointer which gives the pilot *automatic* and *continuous* bearings regardless of the heading of the plane. Once tuned to the desired broadcast or range station, this Direction Finder, unaided, fixes on the station heading so the pilot can set his course and *fly the pointer home.*

■ Flight problems are further simplified because this super-sensitive instrument gives the pilot non-ambiguous bearing indications, and simultaneous headphone reception. In the teeth of hard rain, dust, snow, or other severe conditions, static-free reception is maintained through the use of *shielded* crossed loops.

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■ The Sperry Automatic Radio Direction Finder comes in single and dual types. Equipment includes a self-contained power supply . . . 12- or 24-volt operation is made available by throwing one switch on the receiver. Remote bearing indications can be used, if desired. Available for immediate delivery.

◀ **THE SPERRY** *Automatic Radio Direction Finder is used by TWA, Braniff, Colonial, Northeast, Alaska and American Airlines.*

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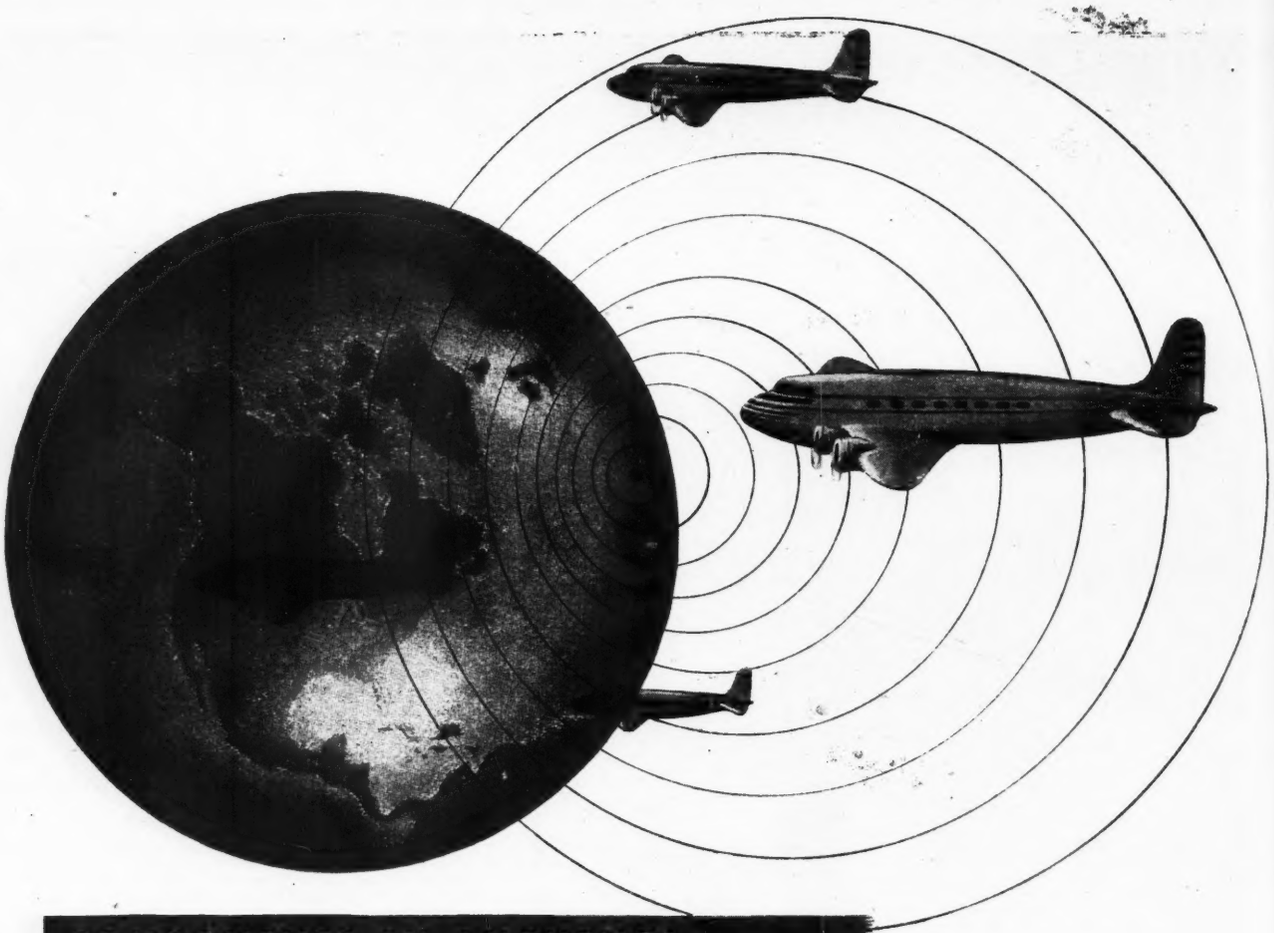

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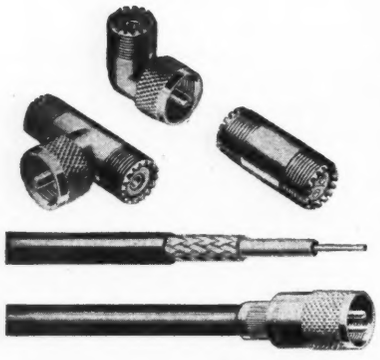
fly the World Airways!

The Amphenol name flies the skies of the world, not only in American planes, but in foreign commercial planes as well. All during the war Amphenol furnished the largest portion of the cables, connectors and plugs for communications and radar equipment used in Allied planes. Today Amphenol continues to be the world's largest single source for these components.

From the standpoints of safety and efficiency of operation, complete dependability of communication is absolutely essential in the air. Amphenol components for airborne radio and electronic equipment have these surpassing qualities by all standards of precision manufacture and electrical correctness —in all indicated applications.



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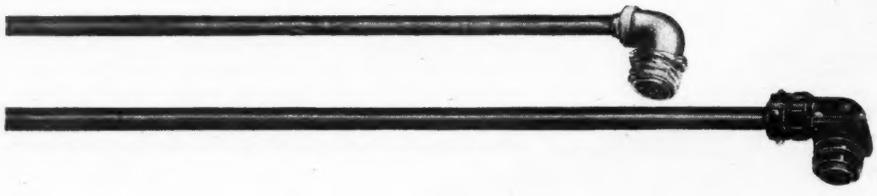
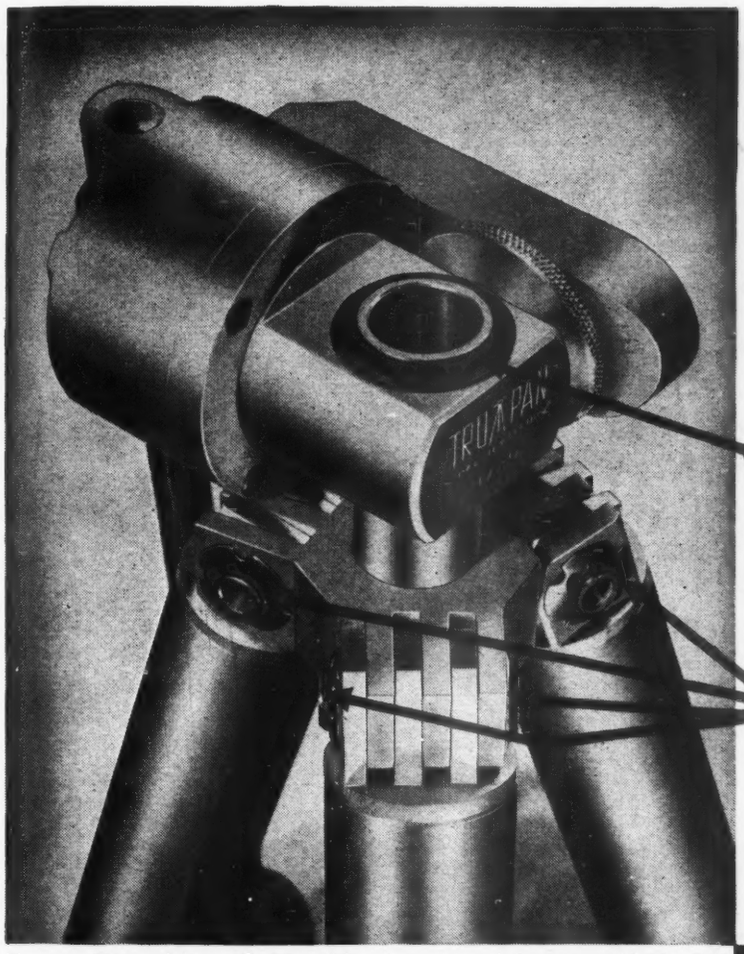


HOW WALDES *TRUARC BOWED RETAINING RINGS* GIVE PRE-DETERMINED TENSION!



Trupan Tripod Manufactured by Accmatool Co., Inc., N. Y. 25

NINE TRUARC RINGS ELIMINATE EXPENSIVE MACHINING ON ACCMATOOL "TRUPAN" TRIPOD

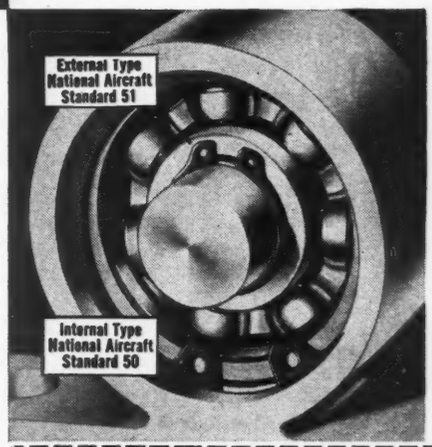
Use of 9 TRUARC retaining rings in manufacture of the TRUPAN Tripod has resulted in a light, compact design—with reduced production costs. Truarc rings eliminate expensive machining required for nuts, threads, screws and shoulders.

1. A ***Truarc Bowed ring*** **and a standard Truarc ring position the vital center pivot pin. The bowed ring exerts a downward pressure of 50 lbs.—gives two-way spring action—*takes up end-play resiliently.* "Shimmy" from cumulative tolerances in manufacture, or from constant wear is eliminated.**

2. **Each leg is positioned on its hinge by a spring washer and a standard Truarc ring mounted at either end of a small steel hinge pin. This construction assures constant tension. The Tripod sets up accurately without adjustments, indefinitely.**

Waldes Truarc precision retaining rings eliminate costly machining by replacing nuts, shoulders, collars and cotter pins. They allow lighter, more compact units—make assembly and disassembly quicker, easier. Truarc rings give better, more dependable retention because their mathematically precise construction insures lasting, perfect circularity—insures a never failing grip. There's a Truarc ring for every mechanical product.

WALDES
TRUARC
TRADE-MARK
RETAINING RINGS
WALDES KOHINOOR INC., LONG ISLAND CITY 1, NEW YORK



FREE!

Mail this coupon today for technical data sheets describing the Bowed and other newly developed Truarc Retaining Rings.

REG. U. S. PAT. RE—18,144

Waldes Kohinoor, Inc., Dept. 15D, Long Island City 1, N.Y. Please send me technical data sheets on the newly developed Truarc Rings.

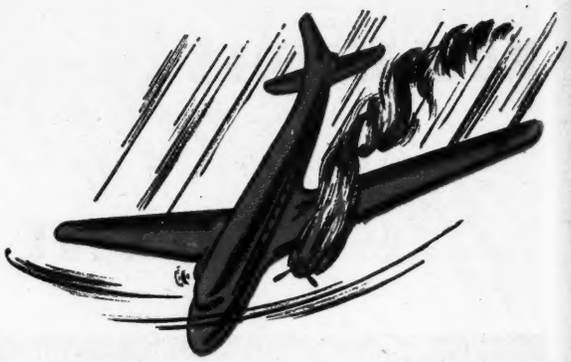
Name & Title_____

Company_____

Address_____

City_____ Zone____ State____

WALTER
Crash Trucks



Get through in any emergency...

. . . Regardless of weather or running conditions

Accidents usually pick the worst spots at the worst times. But Walter Crash Trucks are ready for the worst. For instance: A plane overshoots the field during a storm and crashes. It must be reached quickly to beat fire hazards, to speed rescues, etc. Even though they must cross plowed fields, bogs, dumps, snow, soft dirt, mud or steep grades—Walter Crash Trucks get to it fast. They have the 100% traction and power of the Walter Four Point Positive Drive.

In this drive system, power is proportioned to the FOUR driving wheels according to their traction, by three automatic locking differentials. Should one, two or even three wheels lose traction—the mates carry on. This also eliminates bogging down in emergency towing, as well as adding surefooted safety when speeding over treacherous ground.

Walter Crash Trucks have high ground clearance and each axle is a solid bar protecting the vital driving mechanism. You will never find a ripped axle housing on a Walter Crash Truck! Other features include tractor type transmission, engine forward design, suspended double reduction drive. Write for full information about these unique trucks—their extra traction may save lives on your field some day!

WALTER MOTOR TRUCK CO. 1001-19 Irving Ave., Ridgewood 27, Queens, L. I., N. Y.

WALTER CRASH TRUCKS

SAFE FAST ADAPTABLE

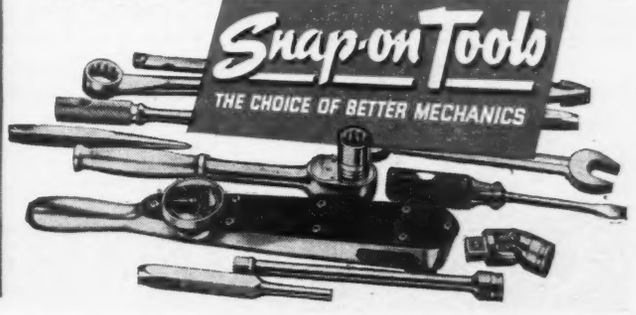
Snap-on BOXOCKET WRENCHES

Powerful, safe leverage that invites confident wrench speed

Slipping handily into hard-to-get-at places . . . engaging the nut on all *six* corners with an encircling can't-slip-can't-spread grip . . . needing only *half the space* of an end wrench for full handle movement . . . Snap-on Boxockets are *speed* tools and *safety* tools on tough nut-turning operations. Chamfered openings slip readily over the nut. Double broaching permits operation within a 15° arc. Round handles provide comfortable grip. Snap-on Boxockets work swiftly and efficiently in many spots inaccessible to other wrenches.

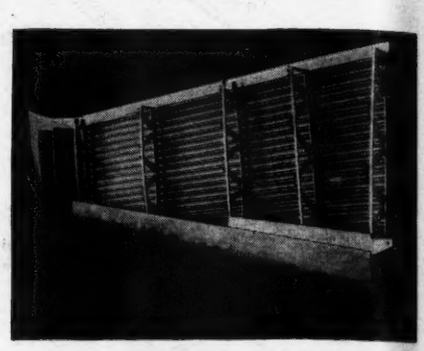
For maximum usefulness on a wide range of work, Snap-on offers 13 types of its popular Blue Point Boxockets — in angled, offset, combination and flare nut heads — and in standard wrench sizes from 3/16" to 4 5/8". Available through Snap-on's nationwide direct-to-user tool service. Write for the Snap-on catalog of industrial wrenches.

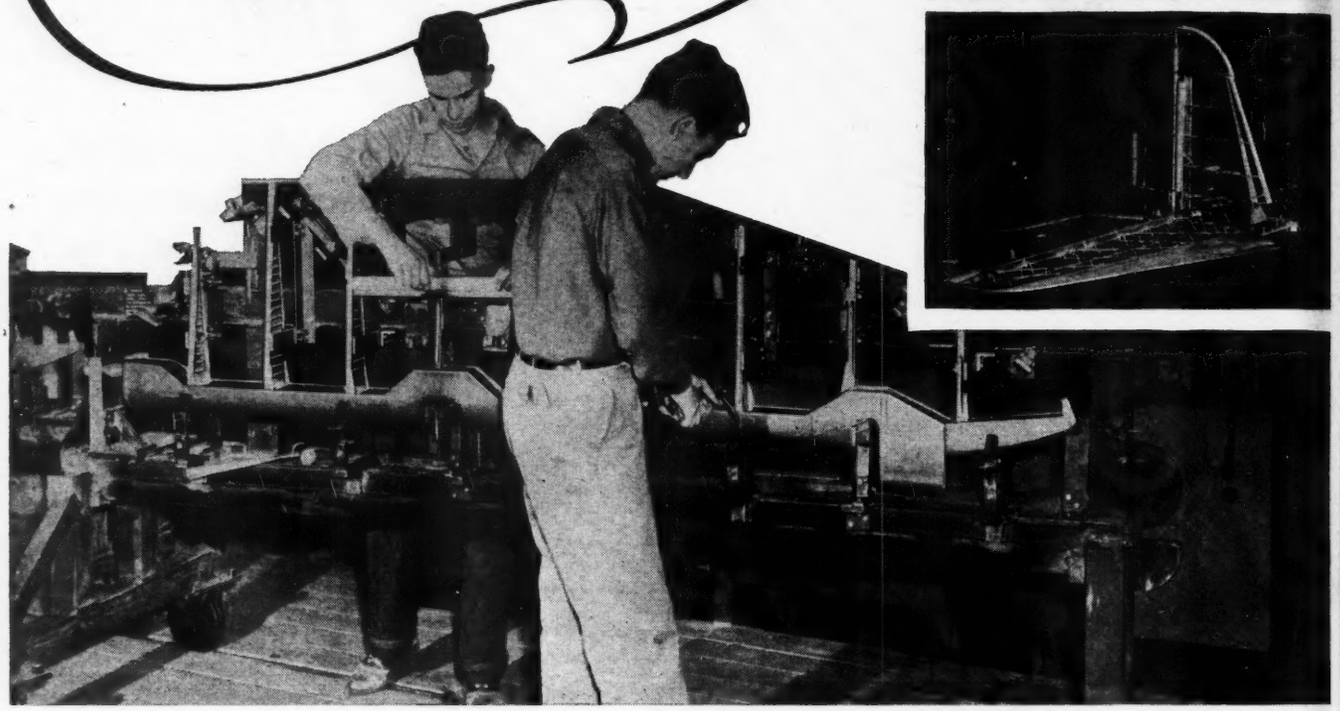
SNAP-ON TOOLS CORPORATION
8020-G 28th AVENUE • KENOSHA, WISCONSIN



FOR THE IMPROVEMENT OF STRUCTURAL PARTS AND CONTROL SURFACES

-nothing equals Stainless Steel!





BECAUSE it will *outperform* other materials, U·S·S Stainless Steel is finding increasing application in aileron struts, elevator frames, stabilizer and rudder frames, fuselage skeletons, etc.

U·S·S Stainless Steel makes possible the highest strength-weight ratios. Its superlative corrosion resistance eliminates the need for protective coatings—makes it unnecessary to provide for weakening by corrosion.

Correct design, by making use of stiffeners, corrugations, box columns, and other readily built-up structures, results in thin-walled, lightweight constructions which retain their superior strength indefinitely. U·S·S Stainless Steel's greater resistance to fatigue, shock and abrasion are assurance of longer life and lower maintenance costs.

The U·S·S Stainless Steels developed for aircraft use not only have exceptional formability but can be spotwelded 20 to 100 times faster than riveting. Thus they lower fabrication costs and make it possible to take full advantage of the latest improvements in plane design and fabrication techniques.

We can supply U·S·S Chromium Nickel and Chromium Stainless Steels not only in many different analyses but in the most complete range of forms, sizes and surface finishes anywhere obtainable.

Our metallurgists will gladly cooperate with you in using them most efficiently.

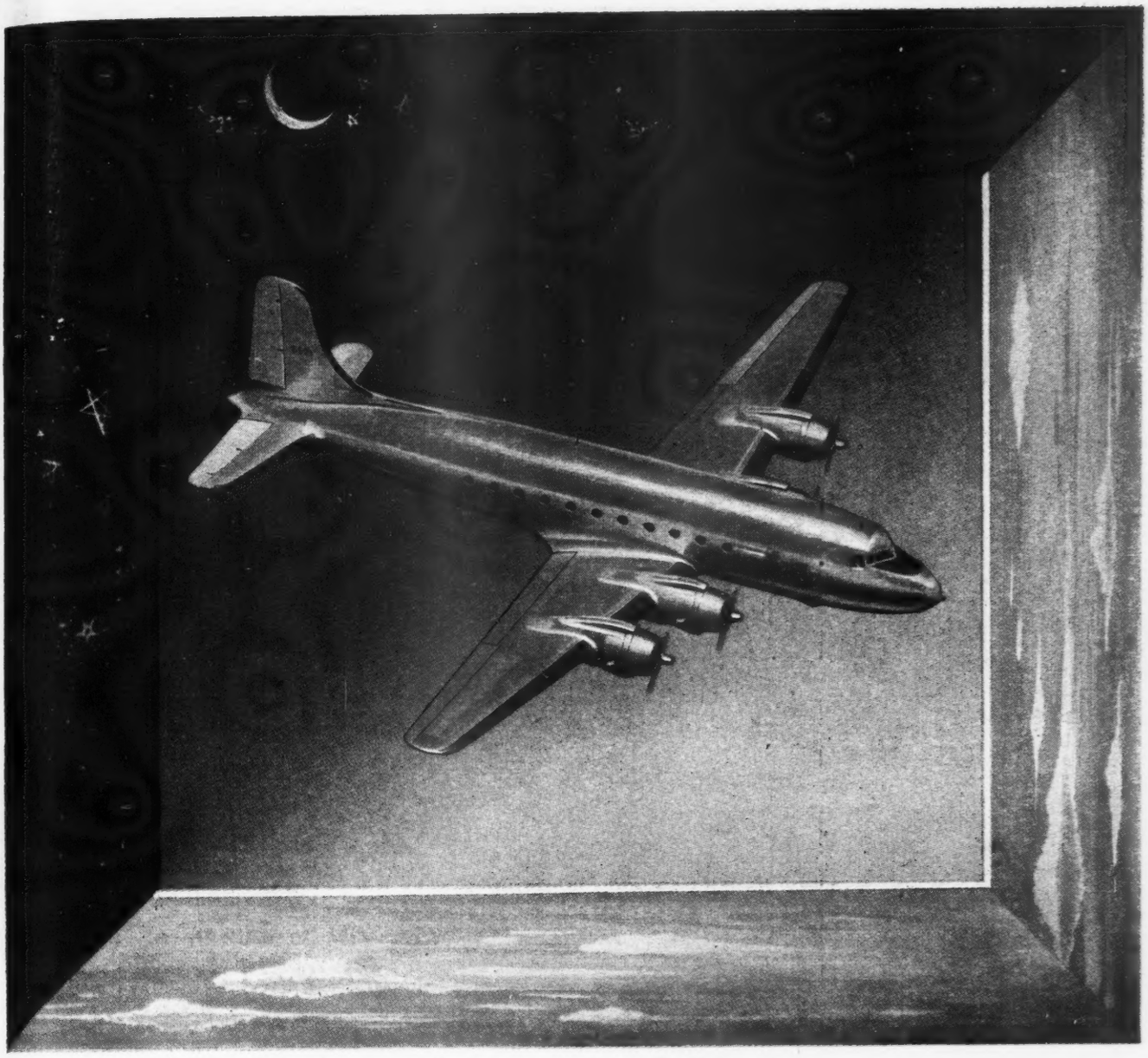
U·S·S STAINLESS STEEL

SHEETS · STRIP · PLATES · BARS · BILLETS · PIPE · TUBES · WIRE · SPECIAL SECTIONS

USS STAINLESS STEEL UNITED STATES STEEL

AMERICAN STEEL & WIRE COMPANY, *Cleveland, Chicago and New York*
CARNEGIE-ILLINOIS STEEL CORPORATION, *Pittsburgh and Chicago*
COLUMBIA STEEL COMPANY, *San Francisco*
NATIONAL TUBE COMPANY, *Pittsburgh*
TENNESSEE COAL, IRON & RAILROAD COMPANY, *Birmingham*
United States Steel Supply Company, Chicago, *Warehouse Distributors* · United States Steel Export Company, New York

UNITED STATES STEEL



DEPENDABLE

Day and Night

WHENEVER YOU FLY
WHEREVER YOU FLY

DEPEND ON... **DOUGLAS DC-4**

K-2400 SERIES

A leak-proof, light weight engine primer, now available in two sizes:

1. **The SHORT—3¾" overall length, weighing approximately 2.5 oz.**
2. **The LONG—5 5/16" overall length, weighing approximately 3.0 oz.**

Latest addition to KOHLER Aircraft Valves and Fittings

KOHLER'S new "All-Aluminum" engine primer, developed specifically for the light aircraft field, has a smooth operating piston as it rolls on its "O" ring and forms a positive seal eliminating the packing, packing follower, and the packing washer.

Kohler valves and fittings, made in a wide variety of types and sizes, have been supplied in great quantities to leading aircraft manufacturers and the Armed Services—and were awarded the "approved" rating, for quality control, by the Army Air Forces. This evidence of precision, care in manufacturing, and inspection control is typical of the 73-year-old tradition of Kohler quality.

With complete facilities for forging, machining and anodyzing centered in one plant, Kohler is ready to serve your needs promptly and reliably. Write for Catalog 7-AV, Kohler Co., Kohler, Wisconsin.

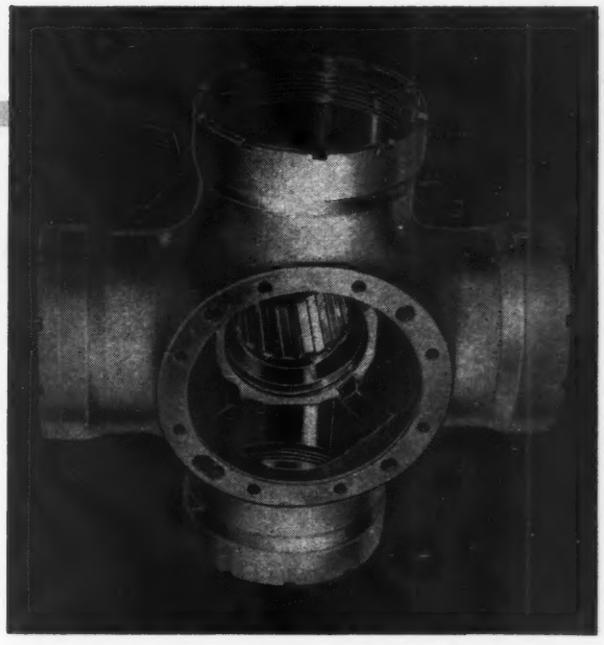
KOHLER OF KOHLER

PLUMBING FIXTURES AND FITTINGS • HEATING EQUIPMENT • ELECTRIC PLANTS

Terrific is a mild word

for stresses in the "prop" hub

of the HELLDIVER



Imagine 1900 horses hitched to this one small piece of steel to pull it apart and you have a fair idea of the terrific stress the propeller hub on a Helldiver must withstand at full throttle and r.p.m. setting.

Propellers for the Helldiver are supplied by the Propeller Division of The Curtiss-Wright Corporation. The 4-way propeller hubs are forged by The Canton Drop Forging & Mfg. Co. from Timken fine alloy forging steels.

These steels have been chosen for these and many other vital parts because they provide safe, dependable performance in the most severe applications.

Such unexcelled performance comes from time-proven Timken control of uniform surface and internal qualities assuring forging economy and uniform properties in finished parts.

Ask our technical organization to send a specialist to help you select (from steels made under the most precise practices known to the steel industry) the one Timken alloy to most economically meet your needs. Write Steel and Tube Division, The Timken Roller Bearing Company, Canton 6, Ohio.

TIMKEN
TRADE MARK REG. U. S. PAT. OFF.
Fine Alloy
STEEL AND SEAMLESS TUBES

★ YEARS AHEAD — THROUGH EXPERIENCE AND RESEARCH

SPECIALISTS in hot rolled and cold finished Alloy Steel Bars for forging and machining applications, as well as a complete range of Stainless, Graphitic and Standard Tool Steel analyses. Also Alloy and Stainless Seamless Steel Tubing for mechanical and pressure tube applications.

Class of the Airfields

By making possible the building of thousands of airports and airfields, the National Airport Act opens the door to sound and tremendous expansion of civil aviation.

Butler engineers, pioneers in the field, are ready. Although limited by current material shortages, Butler factories are geared up to supply unlimited numbers of ultra modern steel hangars by the time new, modern airports can be completed.

Prime example is the Butler Radial Hangar, shown here in the single and in the multiple hangar units.

Up, Over and Under Radial Door

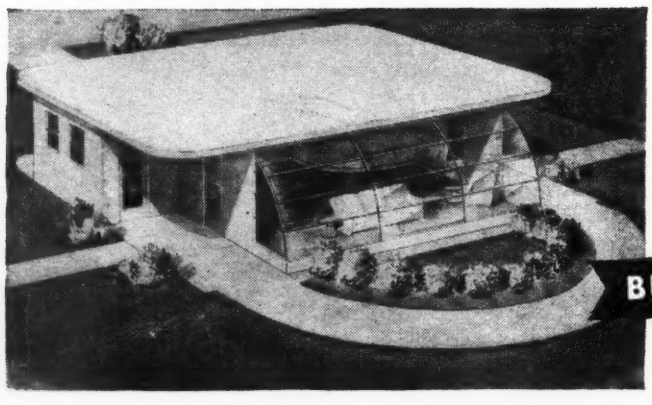
Manually or motor operated, it freely raises up, tilts over and comes to rest under the radial roof out of the path of wind and plane.

Roomy Shop or Club Quarters

For the private owner, the single unit provides, in one front corner, club or office quarters; in the other, well daylighted space for shop and parts storage. Similar space is afforded in each end hangar of the multiple unit arrangement.

Turn-Key Privacy For Plane, Pilot and Parts

Steel frame and specially corrugated galvanized steel radial shell combine to give maximum structural strength and protection against fire, weather and tampering. As single unit or as partitioned multiple unit hangars, the Butler Radial affords turn-key privacy to the private plane owner.



BUTLER BUILT
Reg. U.S. Pat. Off.

Administration Building Chosen For First Model Airpark

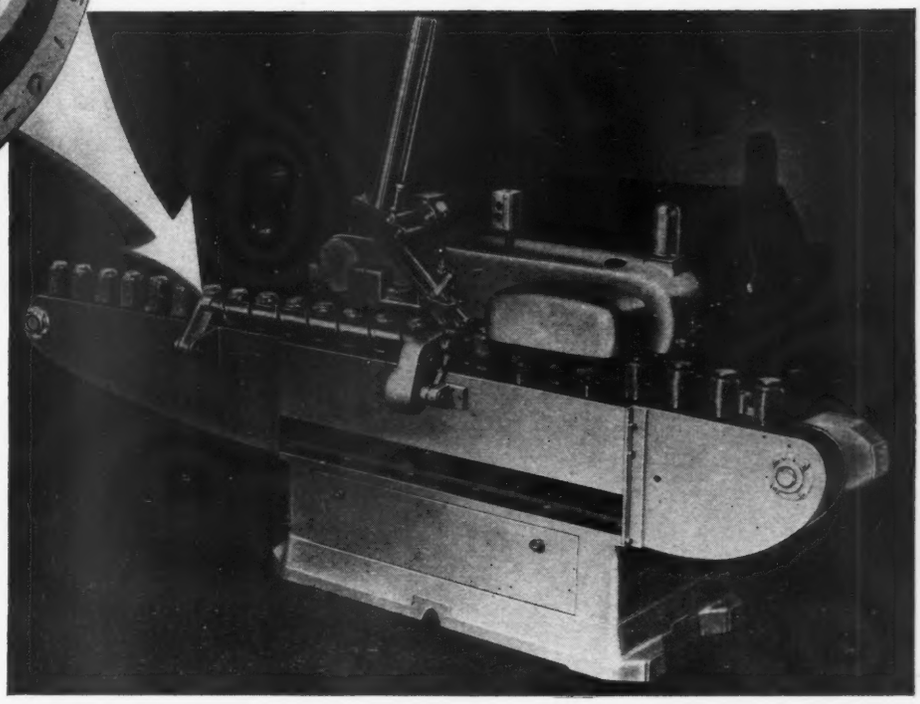
In early June, Eldon, Missouri dedicates a modern airpark. It is widely proclaimed as the model for thousands of land-locked communities which want to reap the benefits of an air-link with the air lanes. Chosen for the Administration Building of the model Eldon Airpark was the Butler key-locked, panel-framed steel building at the left.

BUTLER MANUFACTURING COMPANY

Factories: Kansas City, Galesburg, Minneapolis
Sales Offices: 7406 East 13th St., Kansas City 3, Missouri
906 Sixth Ave. S.E., Minneapolis 14, Minnesota

HEIM UNIBAL

SPHERICAL BEARINGS



As used in the NEW ANCHOR STERISEAL MACHINE

The Anchor Hocking Glass Corporation, Lancaster, Ohio, supplies the new Anchor Steriseal Machine to food packers for high production steam vacuum sealing of glass containers with Anchor AH-N Caps. A small, but important part of this machine is the Heim Unibal Spherical Bearing used to support one end of the Helicoid Timer.

HEIM also makes UNIBAL ROD ENDS

HEIM UNIBAL SPHERICAL BEARINGS

for correction of misalignment

Developed during the war for exclusive use in airplane construction, the unusual principle used in making the Heim Unibal Spherical Bearing is meeting with enthusiastic approval by American Industry in general. Using only one ball instead of a double row of balls in a race, a greater surface supporting area is presented and heavier loads can be carried without breakage. Longer life at lower initial cost, coupled with the self aligning feature of this new type of bearing make it a must for today's production needs.

PLEASE WRITE FOR CATALOG NO. 11

THE HEIM COMPANY
FAIRFIELD CONNECTICUT

For the "Swift Completion of their Appointed Rounds"

The mail goes through!

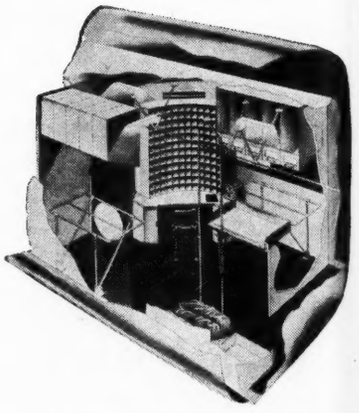
For "neither snow nor rain nor sleet nor gloom of night stays these couriers from the swift completion of their appointed rounds."—the creed of a great Government service.

"Swift completion" has become an increasingly important part of this service—and Air Mail has lent wings to the Post Office Department's traditional speed.

With characteristic imagination, Fairchild engineers now offer *new* wings for the mail. They have created an interior arrangement for the Packet that converts this cargo carrier into a *flying mail car*—a plane to carry air mail exclusively—and efficiently—*by the ton!*

It is the logical answer to the ever-increasing demand for mail by air. With its ability to use less-than-average length runways; carry heavy loads economically for long *or* short distances; to load and discharge cargo fast, the Packet is a transport to widen immeasurably the scope of Air Mail service—even to off-the-line points.

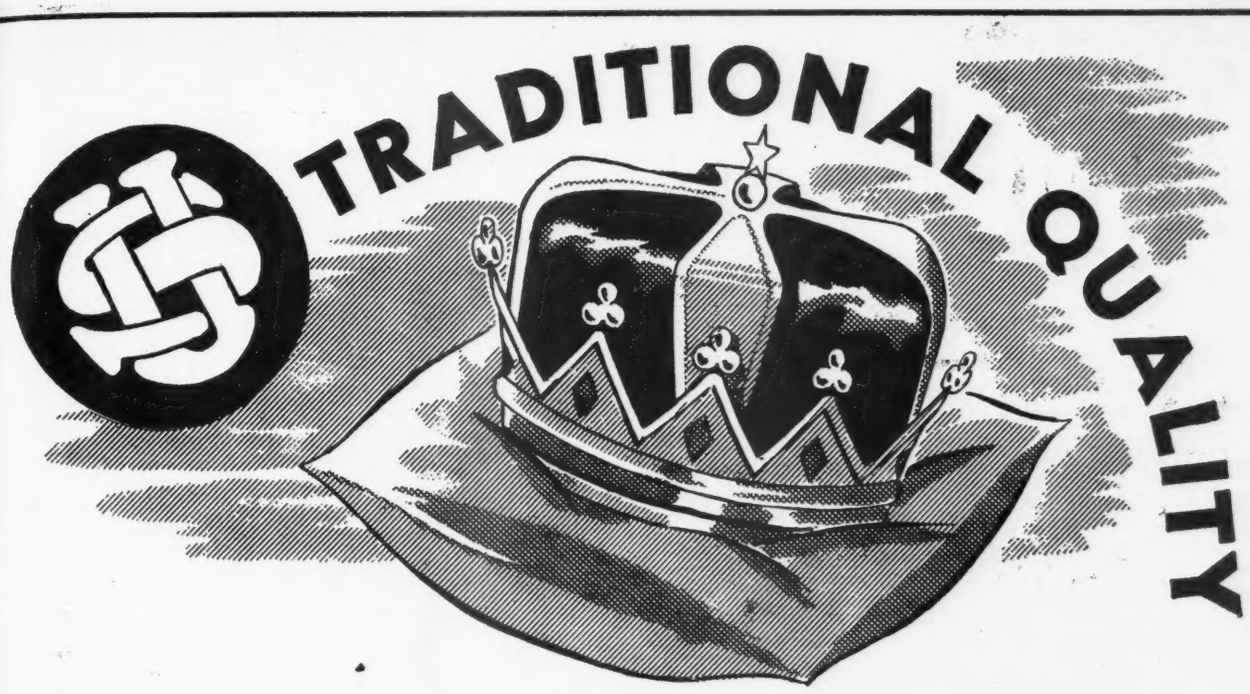
With the design for a flying mail car, typical Fairchild engineering ingenuity has again created the "touch of tomorrow in the planes of today"—converted the versatile Packet into a transport that anticipates the day when all first class mail will be sped toward its destination by air.



A LOOK INSIDE. This ingenious sorting section permits air mail clerks to sort mail *in flight.*

Fairchild Aircraft

Division of Fairchild Engine & Airplane Corporation, Hagerstown, Maryland



A STAR IN OUR CROWN . . . MONEY IN YOUR POCKET

More precious to this company than all the physical assets is UNITED STATES TRADITIONAL QUALITY . . . *more precious to you* is the quality which *puts money in your pocket because the tools stand out as superb examples of the toolmaker's craft.*

Put this to the test . . . do as leaders in your industry have been doing for 48 years . . . . . respect the GOOD MECHANICS' CHOICE . . . depend on

UNITED STATES ELECTRICAL TOOLS FOR PRODUCTION AND MAINTENANCE

THE United States ELECTRICAL TOOL CO. CINCINNATI 14, OHIO

Your Jobber Stands By to Serve

United States Electric Tools and Accessories are carried in stock by leading jobbers. Their representatives are skilled in helping users select the proper tools for the jobs on hand. You can depend on any U. S. Electric Tool Jobber for intelligent advice, not only on electric tools but on thousands of other items. Enjoy this economical convenient service.

Write for catalog, delivery dates and other information.

Model 14 ARD
Weight 4¾ lbs.
Length 7½"

SPECIAL ¼" LIGHT WEIGHT

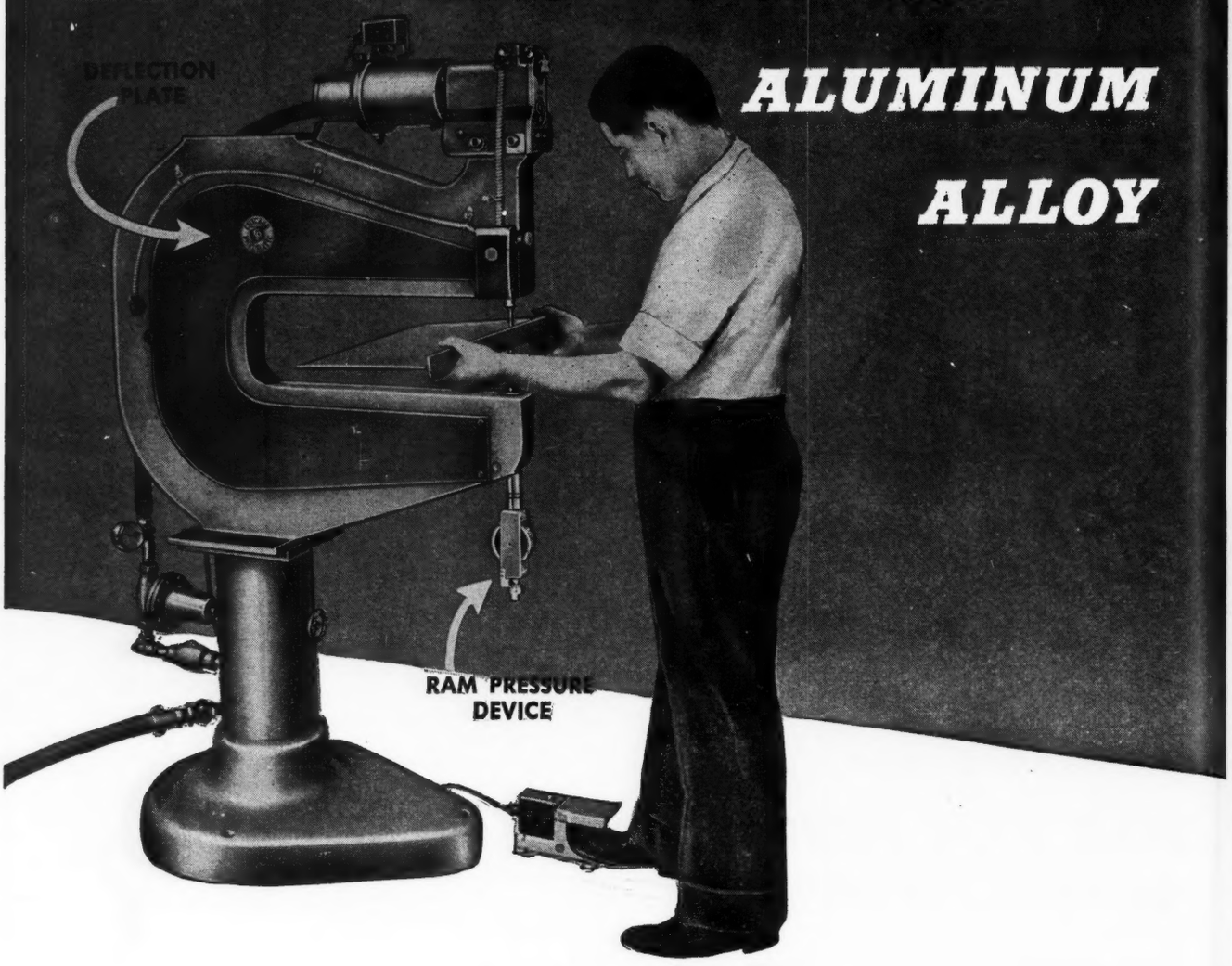
AVIATION DRILL

Model 14ARD

Extremely light in weight with plenty of power. Designed to withstand rough handling on the production line or for maintenance. Perfect balance eliminates wrist fatigue. Equipped with ¼" capacity 3-jaw geared chuck with key, rubber covered cable and attachment plug. 100% anti-friction bearings.

Length 7½ in. Weight 4¾ lbs.

NOW! COIN DIMPLING MAGNESIUM and ANY ALUMINUM ALLOY



THE CP-450EA Pneumatic Riveting-Dimpling Machine assures precision coin dimpling of magnesium and the harder aluminum alloys. The deflection plate and the adjustable coining ram pressure device (exclusive with Chicago Pneumatic) assure positive control of pressures between dimpling dies, irrespective of any line pressure variations.

This improved, electrically controlled machine elimininates cracked dimples . . . controls flushness to plus or minus .001" . . . and assures accurate nesting of dimples. *Write today for further information covering the improved model CP-450EA riveting-dimpling machine.*

★★★★★★★★★
PNEUMATIC TOOLS
ELECTRIC TOOLS
HYDRAULIC TOOLS
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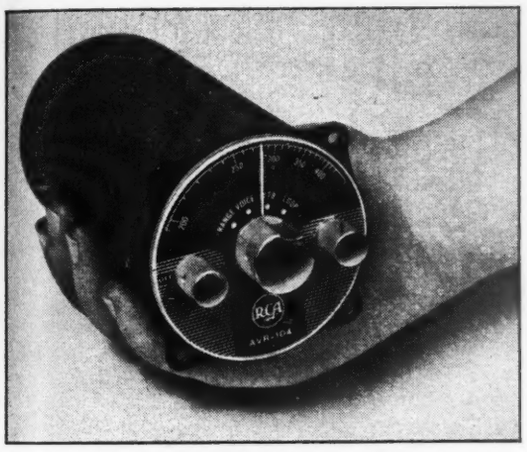
CHICAGO PNEUMATIC TOOL COMPANY

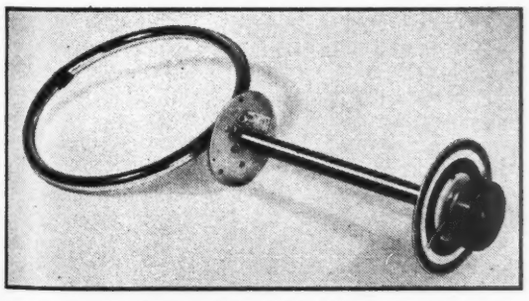
General Offices: 8 East 44th Street, New York 17, N. Y.

★★★★★★★★★
AIR COMPRESSORS
VACUUM PUMPS
DIESEL ENGINES
AVIATION ACCESSORIES

RCA Transmitter AVT-III. Light, compact, powerful, efficient—ideal for the light-plane owner who wants a dependable two-band transmitter at a low price.



RCA Receiver AVR-104. Exceptionally small size—mounts in standard panel instrument hole. 200-415 kc band, 278 traffic control position, built-in range filter.



RCA Loop Antenna AVA-129. Light weight, directional and rotatable antenna, for use with any RCA Aircraft Radio Receiver for radio-direction finding and air navigation.

RCA presents

a complete radio system for the light plane

Here it is—a complete radio system—built by RCA—to bring to the light-plane flyer two-way radio communication with a rotatable loop antenna for radio navigation.

You'll be "on the air"—in the air—with RCA's compact two-channel AVT-111 Transmitter, with fixed or trailing antenna, on 3105 or 6210 kc.

The AVR-104 Receiver occupies only a standard panel instrument mounting space and covers the 200 to 415 kc range. It has a 278 kc fixed-tuned position for reception of traffic control instructions. Power supply and IF-Audio units can be mounted in any convenient place in the plane . . . cable lengths are not critical.

The chromium-plated AVA-129 Loop Antenna mounts on top or bottom of the aircraft fuselage—and provides a double check on course flown as well as guidance off the airways. Cross-country flight can be undertaken with real confidence—cross-bearings make it easy to fix position at any time.

You'll want to know more about this modern light-plane radio "family." For detailed specifications and the complete story *write today* to Dept. 15-G.

AVIATION SECTION

RADIO CORPORATION of AMERICA

ENGINEERING PRODUCTS DEPARTMENT, CAMDEN, N.J.

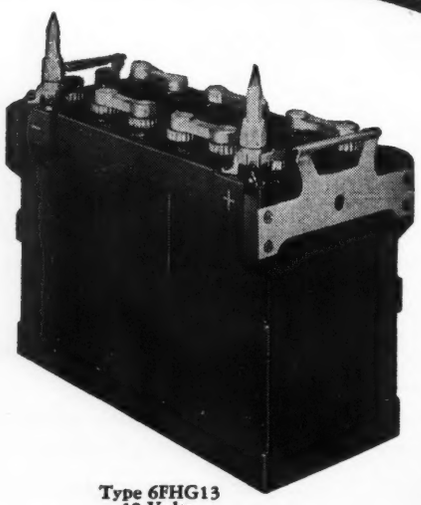
Exide

AIRCRAFT BATTERIES

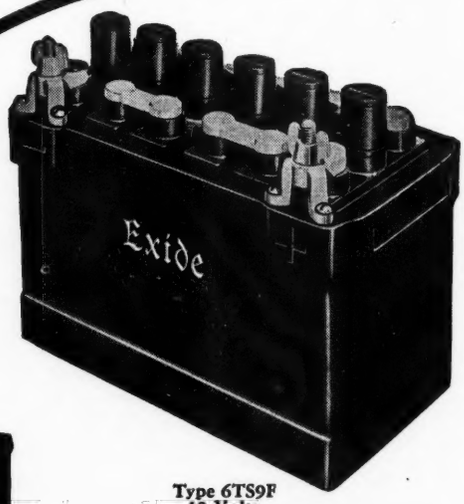
Exide has pioneered in the development of batteries designed specifically for aircraft. They assure safe, trustworthy performance—low maintenance cost. That's why Exides are favored by engineers, manufacturers, maintenance men, and plane owners.

There is an Exide Aircraft Battery for planes of every type. Exide sales and service cover the country from coast to coast.

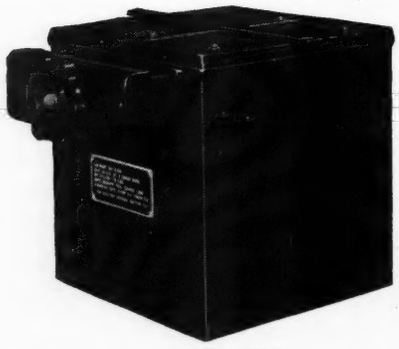
THE ELECTRIC STORAGE BATTERY COMPANY, Philadelphia 32
Exide Batteries of Canada, Limited, Toronto



Type 6FHG13
12 Volts
AIR TRANSPORT BATTERY
Used by leading airlines

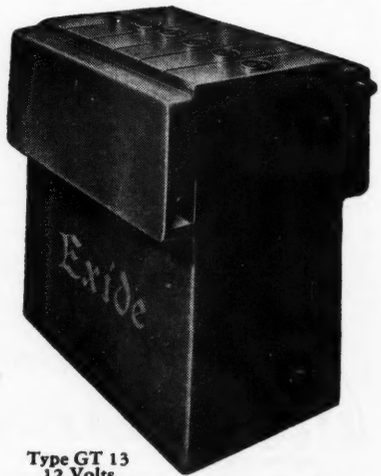


Type 6TS9F
12 Volts
PERSONAL PLANE BATTERY
For lights, radio and starting



Type 12TS9L
24 Volts
MILITARY TYPE BATTERY
For military and reconverted
Government planes

Type 3AC7
6 Volts
LIGHT PERSONAL PLANE BATTERY
For ignition and small lighting loads



Type GT 13
12 Volts
ADVANCED TYPE BATTERY
For extra duty

THE MODERN MAGIC CARPET ★
★T. M. REG. U. S. PAT. OFF.

Steady as you go

Product of many years' research and steady development, the Bell Helicopter is the first rotary-wing aircraft to receive an Approved Type Certificate from the CAA.

Bell is building helicopters for delivery late this summer. We believe ardently in the future of this unique rotor-craft. It offers a new and almost unlimited utility to government agencies, industry and agriculture.

Because it can take off vertically and fly low and slow, the Bell Helicopter unlocks the doors to hitherto inaccessible places. No landing strips or costly ground facilities are needed. A patented gyro stabilizing device assures inherent flight stability and offsets any tendency to tilt, pitch or sway. All the way is steady as you go.

To find out what this new kind of flight can mean to you in your business—write Helicopter Division, Bell Aircraft Corporation, P. O. Box 1, Buffalo 5, New York.

BELL Aircraft CORPORATION

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PACEMAKER OF AVIATION PROGRESS—DESIGNERS AND BUILDERS OF THE AIRACOBRA, KINGCOBRA AND AMERICA'S FIRST JET FIGHTER—AIRACOMET

ADV. BY N. W. AYER

Gordon G. Johnson (right), Plant Mgr., Lycoming Division—The Aviation Corporation, congratulates Ted V. Weld, V.P., Piper Aircraft Corp., on the completion of the 20,000th Piper Cub—a Super Cruiser model, powered by a 100 h.p. Lycoming engine, 0-235-C.

20,000TH PIPER CUB ...with a LYCOMING out-in-front

More power to Piper!

Piper's installation of *Lycoming* power in their 20,000th, as in thousands of its fine predecessors, is a tribute to *Lycoming* reliability. It takes years of seasoned experience to build good, safe planes. Experience alone can engineer sound, reliable engines.

Lycoming, builder of engines since 1910, offers advanced designs for every personal plane need from 65 h.p. to 350 h.p. Unequaled in engineering excellence and proved dependability, *Lycoming* engines in terms of initial cost, maintenance and reliability are the lowest priced on the market.

For safe, sure flying—insist that your plane is powered by *Lycoming*.

LYCOMING
AN AVCO PRODUCT
AIRCRAFT ENGINES

Lycoming Division, Dept. B-4, The Aviation Corporation, Williamsport, Pa.

Jet+Reciprocating Power=

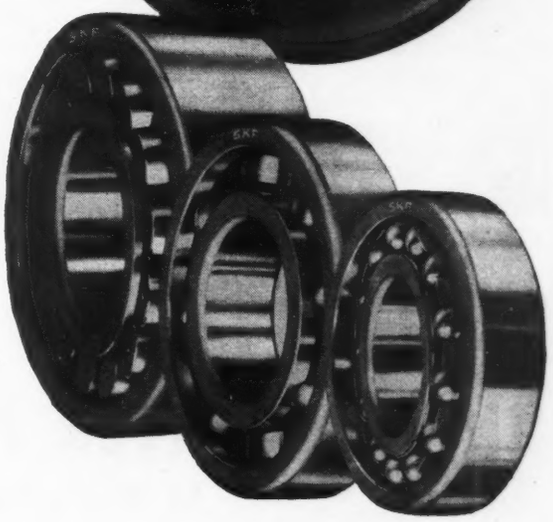
THE SKF-EQUIPPED FIREBALL!

● BUILT BY RYAN AERONAUTICAL CO.

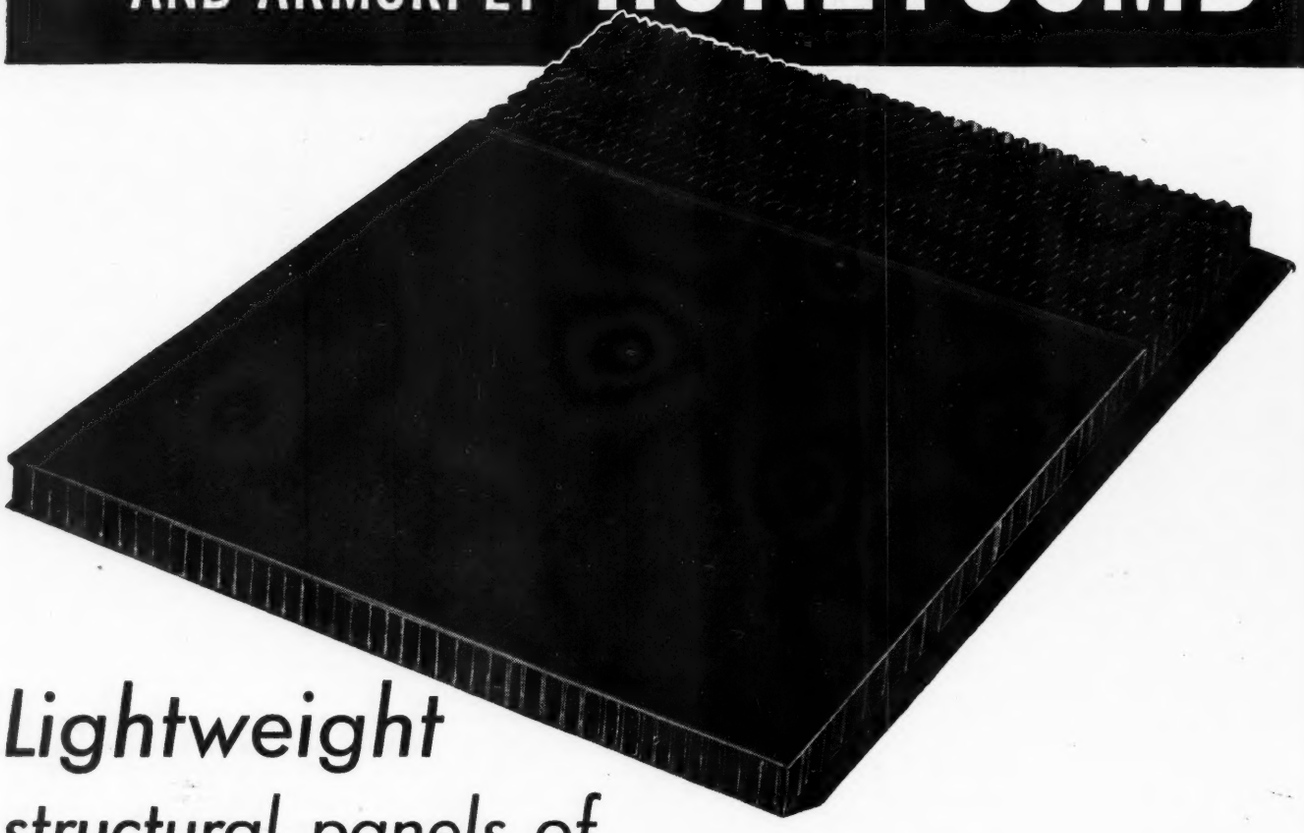
The world's first plane to combine jet and reciprocating power plants, the Fireball, with a maximum range of 1500 miles, streaks through the skies at speeds of more than 300 miles per hour. Naturally, dependable bearings are needed for its fast-moving parts. That's why SKF Bearings are up front on crankshaft and propeller shaft of the 1350 h.p. Wright Cyclone Engine and in the rear on General Electric's turbo-jet engine. Made with infinite care, these precise bearings make certain of reliability under high temperatures at extremely high speeds. Aviation's pioneering achievements and SKF Bearings go together . . . always. 6065

SKF INDUSTRIES, INC., PHILA. 34, PA.

SKF
Puts the Right Bearing in the Right Place



Use WELDWOOD AND ARMORPLY HONEYCOMB



Lightweight structural panels of

AMAZING STRENGTH and STABILITY

. . . now being used for floors, partitions, shelving and other parts by:

American Overseas Airlines, Inc.
Boeing Aircraft Company
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Grumman Aircraft Engineering Corp.
Lockheed Aircraft Corporation
The Glenn L. Martin Company
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Republic Aviation Corp.

. . . extensively used in the famous Lockheed Constellation, the Douglas DC 6 and DC 8 and the new Martin 202, these panels show exceptional stability under extreme variations of temperature and humidity.

Made of phenolic resin impregnated cotton, the honeycomb core weighs as little as 4 lbs. to the cu. ft. Weldwood and Armorply Honeycomb structural panels possess extreme stiffness plus the ability to work up to a yield-point without buckling. Honeycomb cores are made of paper, cloth, Fiberglas, etc., and faced with decorative wood veneers, aluminum alloys, stainless steel, or plastic sheets bonded to the core by a new thermosetting adhesive.

Complete engineering data on request.

UNITED STATES PLYWOOD CORPORATION

55 West 44th Street, New York 18, N. Y.

IRVIN

Chair Chute Safety

FOR EVERY PASSENGER

● In modern cabin airplanes, every passenger may have the protection of the IRVIN CHAIR CHUTE. Inconspicuously installed, it appears simply as a comfortable back in the passenger's chair . . . yet it is ready for instant use.

Illustrations show how quickly and easily the IRVIN CHAIR CHUTE affords its protection:

1. Slip arms into the side straps
2. Buckle breast strap
3. Fasten lap strap

When the passenger rises the chute comes with her.

The increasing use of private cabin planes by business executives has led many companies to insist that their officials and guests have this protection. There's no sacrifice of decoration, comfort, practicability.

New illustrated catalog giving details of all types of IRVIN packs sent on request.

IRVING AIR CHUTE CO.
INCORPORATED
Main Office: 1670 Jefferson Ave., Buffalo 8, N. Y.

Complete Factories in Buffalo, N. Y., Glendale, Calif. (1500 Flower St.), and Lexington, Ky., U. S. A.— Canada, England and Sweden

Now . . . NEW HELP FOR FORECASTING WEATHER in ocean and seaboard areas

Here for the aid of all who sail or fly in marine areas is a special and simplified system for forecasting the weather. Step by step it explains weather conditons prevailing off coastal regions and in open seas . . . discusses the seven basic elements which cause weather changes . . . and clearly tells how to analyze them so as to make accurate weather reports and predictions. From the book—with its plain, non-technical explanations and its hundreds of illustrations, charts, diagrams, maps and tables—you gain sufficient knowledge to solve the various types of weather problems which confront the navigator in all parts of the globe.

Plus:
Weather summaries covering each month of the year for the principal seaports and islands of the world.

Just Out!

METEOROLOGY with Marine Applications

By WILLIAM L. DONN,
Formerly Head of Meteorology Section, U. S. Merchant Marine Academy.

465 pages, 5¾ x 8¾, 327 illustrations, $4.50

This compact, practical guidebook gives you not only a general grounding in meteorological principles but also specific help in applying them to make your runs as quick, safe and efficient as possible. It points out exactly what you should know about the weather elements—temperature, humidity, precipitation, clouds, etc.—to observe them properly. It carefully explains their relationship to each other and their bearing on the state of the weather.

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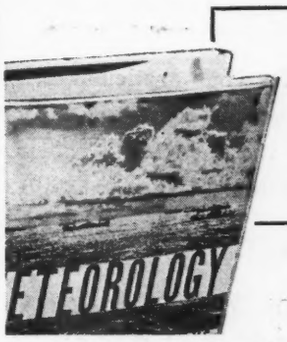

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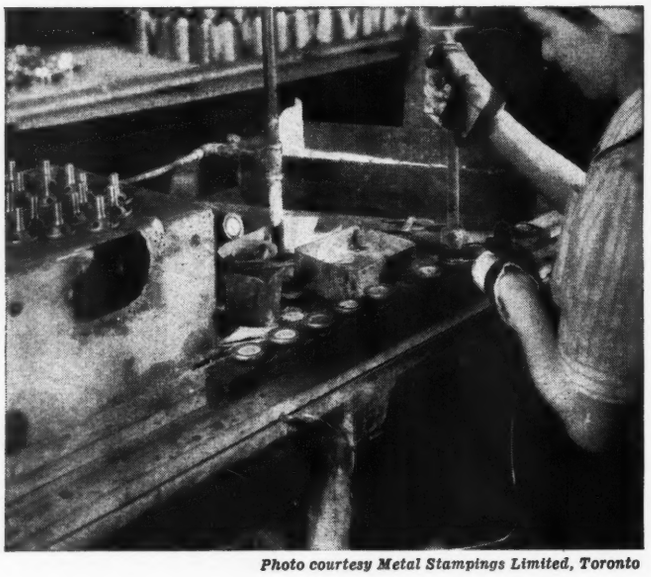

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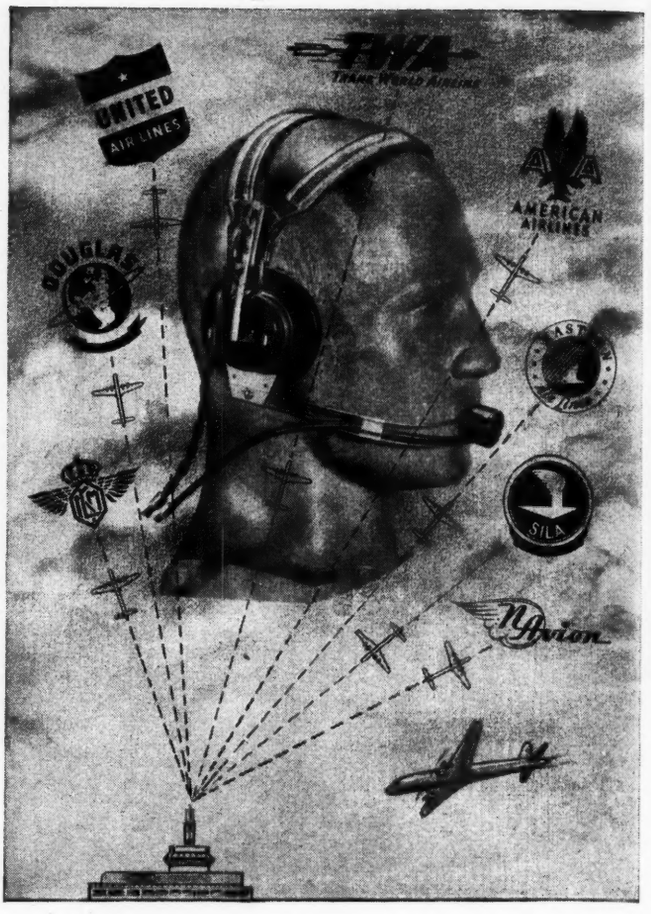

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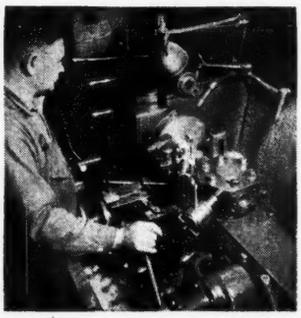

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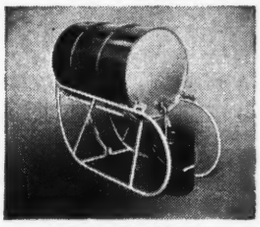

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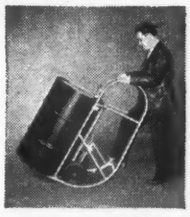

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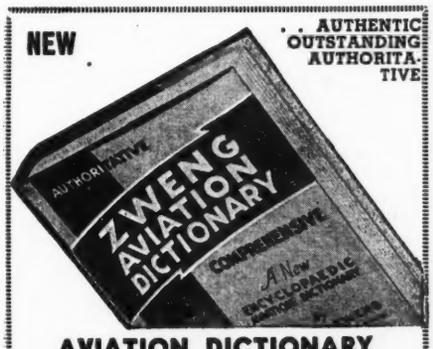

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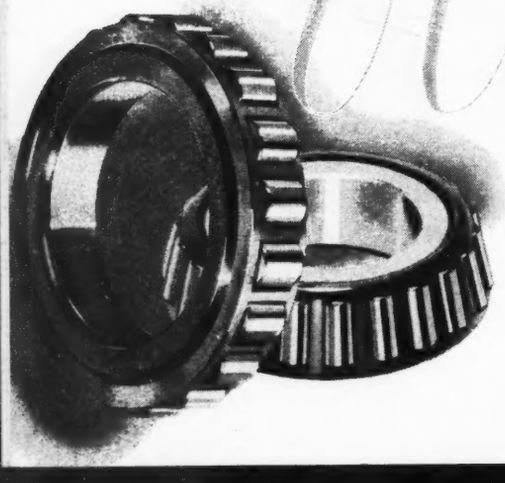

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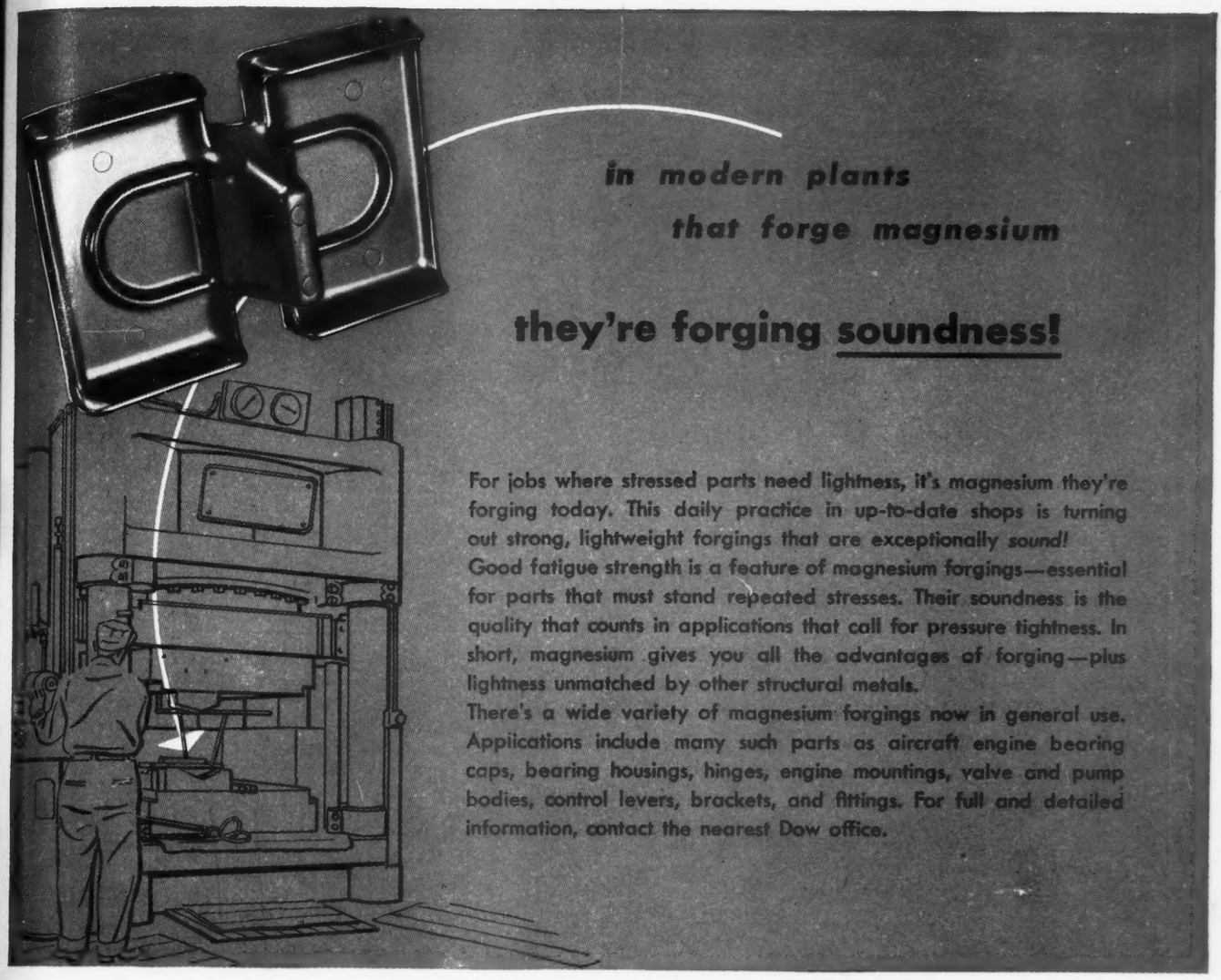

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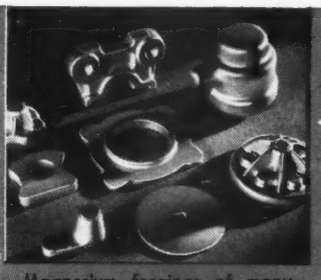

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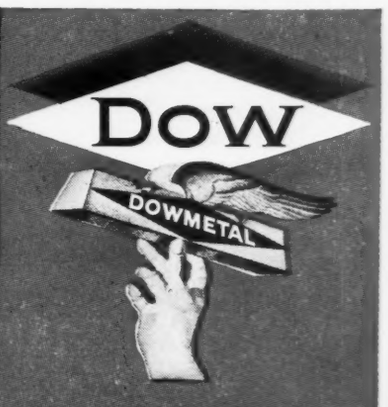

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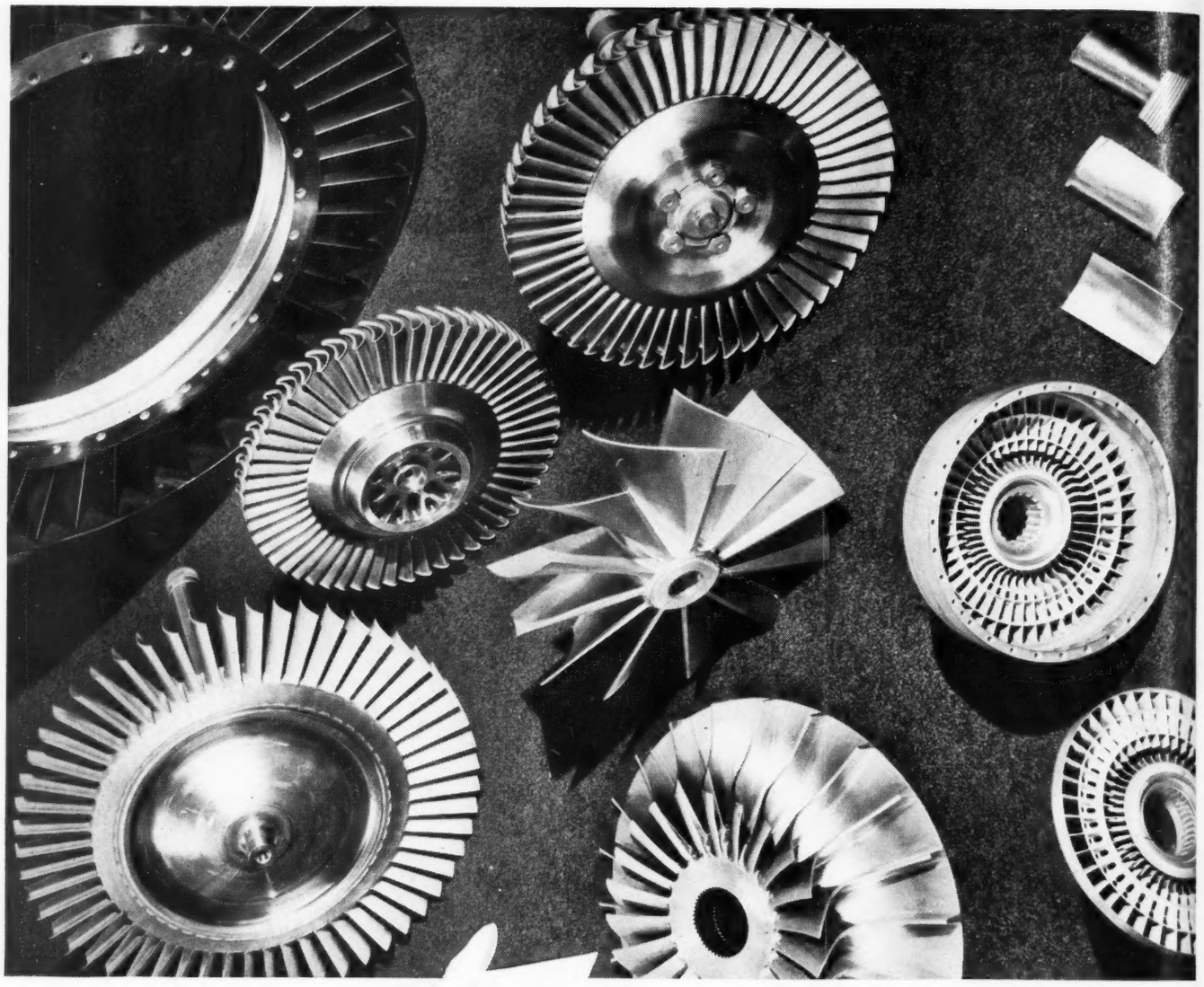

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